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Isolation And Identification Of Fungi Associated With The Spoilage Of Some Selected Fruits In Ibadan, South Western Nigeria

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ABSTRACT: The spoilage of Pawpaw (*Carica papaya*), Orange (*Citrus sinensis*), and Tomato (*Lycopersicon esculentum*) from three selected markets in Ibadan, Oyo State, South Western Nigeria were investigated. Healthy fruits (orange, Pawpaw and Tomato) were brought to the laboratory and allowed to spoil on a laboratory bench. The fruits (Pawpaw, Orange, Pineapple and Tomato) showing spoilage signs were examined for the presence of fungal pathogens inducing spoilage. The isolation of fungi from orange and Pawpaw was carried out on potato dextrose agar (PDA) while that of Tomato fruits was on malt extract agar (MEA). A total of nine (9) fungi isolates were obtained. Of all the samples studied (ripe and unripe Pawpaw fruits), five species of fungi were found to be associated with the fruits decay. The most common fungi found were *Aspergillus flavus*, *A. niger*, *Fusarium solani*, *Penicillium digitatum*, *Rhizopus stolonifer* and yeasts. Three fungal species *Aspergillus niger* (50.0%), *Penicillium digitatum* (100.0%) and *Rhizopus stolonifer* (50.0%); were found associated with deteriorating *Citrus sinensis*. *Aspergillus niger* (50.0%), *Aspergillus flavus* (50.0%) and *Fusarium solani* (50.0%) were associated with *Carica papaya*. The mycoflora found associated with *Lycopersicon esculentum* were *Rhizopus stolonifer* (50.0%), *Fusarium solani* (50.0%) and *Candida tropicalis* (50.0%). Pathogenicity test carried out revealed that all the fungi isolated were pathogenic. The fungi associated with the spoilage of the fruits were identified based on their colonial and morphological characteristics. These fungi species were found in varying degrees. *Aspergillus* species (*A. niger* and *A. flavus*) had the highest rate of occurrence among the isolated fungi (33.3%). This was followed by *Rhizopus stolonifer* and *Fusarium solani* (22.2%) while *Penicillium digitatum* and *Candida tropicalis* were the least encountered (11.1%). Pathogenicity tests revealed that all the isolated fungi were pathogenic to the different fruits. It showed that each infected fruit gave the initial organism that caused the spoilage of the fruit. The rot symptoms obtained were similar to those observed previously on the fruits when subjected to identification procedures. The moulds seen were the same as those of the isolated fungi of fresh fruits which were subject to spoilage. The fruits changed colour slightly after infection and became soft thus could easily be punctured with a finger at the point of inoculation. Of all the isolated fungi, *Aspergillus niger* was highly pathogenic leading to rapid disintegration of treated fruits in 3-5 days while *R. stolonifer* and *Fusarium solani* were moderately pathogenic, and *Candida tropicalis*, *Penicillium digitatum* and *Aspergillus flavus* was least pathogenic, and caused the least amount of rot on fruits. This study detected the profile of spoilage fungi which caused pathogenicity of some local fruits in Ibadan city. It showed that fruits decay is caused by fungi. Since fruits were usually infected by pathogenic fungi, to be effective, production, preparation and preservation of food such as fruit salads must be carried out as rapidly and hygienically as possible using good quality equipment, produce and materials.

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Keywords: *A. flavus*, *A. niger*, *F. solani*, *P. digitatum*, *R. stolonifer*, Yeasts, Orange, Pawpaw, Tomato, spoilage, Pathogenicity.

1.0 INTRODUCTION

Fruits and vegetables are very important and have high dietary and nutritional qualities. Consumption of fruit and vegetable products has dramatically increased by more than 30% during the past few decades (Barth et al., 2009). During the period 1970–2004, US per capita consumption of fruits and vegetables increased by 19.9%, to 694.3 pounds per capita per year (ERS, 2007). Fresh fruit and vegetable consumption increased by 25.8 and 32.6%, respectively, and far exceeded the increases

observed for processed fruit and vegetable products. It is also estimated that about 20% of all fruits and vegetables produced is lost each year due to spoilage (Barth et al., 2009). Raven et al. (2005) reports that 20 new human fungal pathogens are documented each year. Most microorganisms that are initially observed on whole fruit or vegetable surfaces are soil inhabitants, members of a very large and diverse community of microbes that collectively are responsible for maintaining a dynamic ecological

balance within most agricultural systems. Vectors for disseminating these microbes include soil particles, airborne spores, and irrigation water (Barth et al., 2009).

A fruit is the edible part of a mature ovary of a flowering plant. It is usually eaten raw (Zitter, 1985). Fruits could also be described as the succulent or fleshy covering of a nut which is pulpy, often juicy in character. As they were developed from the flower of a plant, they consist of ripened seed or seeds with some tissues attached (Nagy and Shaw, 1980). Fruits play a vital role in human nutrition by supplying the necessary growth factors such as vitamins and essential minerals in human daily diet and that can help to keep a good and normal health (Al-Hindi et al., 2011). Fruits are widely distributed in nature. One of the limiting factors that influence the fruits economic value is the relatively short shelf-life period caused by pathogens attacked. It is estimated that about 20-25% of the harvested fruits are decayed by pathogens during post-harvest handling even in developed countries (Droby, 2006; Zhu, 2006).

Increasing interest in medicinal herbs has increased scientific scrutiny of their therapeutic potentials and safety thereby providing physicians with data to help patients make wise decisions about their use (Oduola et al., 2007). Fruits, apart from being taken as food also have some medicinal importance. The latex from the trunk of the Pawpaw tree is applied externally to speed the healing of wounds, ulcers, boils and warts. The seed is also used to expel worm and the flower may be taken in an infusion to induce menstruation (Oduola et al., 2007). In the Southern part of Nigeria, fruit such as Pawpaw production has improved the diet of the local people, whose diet generally consisted of starch staples lacking essential vitamin and minerals (Baiyewu et al., 2007). These fruits were usually displayed on benches and in baskets for prospective customers in the open markets until sold, thereby exposing them to further microbial infection beside those associated with the fruit surface and those from adjacent infected fruits (Baiyewu et al., 2007; Chukwuka et al., 2010).

Tomatoes are eaten raw or cooked. Large quantities of tomatoes are used to cook soup, juice, sauce, puree, paste and powder, seeds contain 24% oil and this is extracted from the pulp and residues of the canning industry (Chuku et al., 2008; Akinmusire, 2011). Pawpaw fruit can be freshly eaten or cooked. It can also be used in the preparation of jellies, juice and jams. It has great application in the preparation of fruit salad and desserts orange juice is made from fresh healthy oranges. Sweet orange oil is a by-product of the juice industry produced by pressing the peel (Akinmusire, 2011).

The primary cell wall of fruit is composed of approximately 10% proteins and 90% polysaccharides, which can be divided into three groups: cellulose, hemicellulose and pectin (Nathalie, 2006). Numerous cell wall degrading enzymes can be secreted by pathogens to

breach and use the plant cell walls as nutrient sources that reduced post-harvest life and finally lead to develop inedible, undesirable quality and soft rot spoilage (Raviyan et al., 2005; Netsanet et al., 2009; Tomassini et al., 2009; Al-Hindi et al., 2011).

In developing countries, postharvest losses are often more severe due to inadequate storage and transportation facilities. Fungal fruits infection may occur during the growing season, harvesting, handling, transport and post-harvest storage and marketing conditions, or after purchasing by the consumer. Fruits contain high levels of sugars and nutrients element and their low pH values make them particularly desirable to fungal decayed (Singh and Sharma, 2007). Studies by Li-Cohen and Bruhn (2002) had shown that fungi can survive and/or grow on fresh produce and that the nutrient content (carbohydrate, protein and fat) of fresh produce support pathogens.

Fruits are however affected by a wide array of microorganisms causing its decay. These microorganisms, under the influence of environmental factors, pose a serious threat to fruits production. Spoilage refers to any change in the condition of food in which the food becomes less palatable, or even toxic; these changes may be accompanied by alterations in taste, smell, appearance or texture (Akinmusire, 2011). Spoilage fungi that typically produce more diverse and greater amounts of extracellular depolymerases successfully attack and spoil both fruits and vegetables (Barth et al., 2009). Fungi in particular produce an abundance of extracellular pectinases and hemicellulases that are important factors for fungal spoilage (Miedes and Lorences, 2004). Some spoilage microbes are capable of colonizing and creating lesions on healthy, undamaged plant tissue (Tournas and Katsoudas, 2005).

Spoilage microorganisms can be introduced to the crop on the seed itself, during crop growth in the field, during harvesting and postharvest handling, or during storage and distribution (Barth et al., 2009). Those same types of soil-borne spoilage microbes that occur on produce are the same spoilage microorganisms that are present on harvesting equipment, on handling equipment in the packinghouse, in the storage facility, and on food contact surfaces throughout the distribution chain (Barth et al., 2009). Therefore, early intervention measures during crop development and harvesting through the use of good agricultural practices (GAP) will provide dramatic reductions in yield loss due to spoilage at all subsequent steps in the food-to-fork continuum (Eckert and Ogawa, 1988; Barth et al., 2009).

Although available literatures revealed that the importance of fruit is increasing daily, the incidence of microbial attack on this fruit demands attention. Over the years, there has been an increase in the need to identify and isolate the fungi associated with their spoilage. The aim of this study was to isolate and identify the fungi that are associated with the spoilage of Orange, Pawpaw and Tomato fruits sold in some selected markets in Ibadan city, Oyo State, South Western Nigeria.

2.0 MATERIALS AND METHODS

2.1. Fruit source

Fruits (orange, Pawpaw, Tomatoes) both fresh and those found with symptoms of fungal infection were purchased from three different markets located in Ibadan, Oyo State of Nigeria. This study was carried out in Ibadan, Oyo State, located in low humid part of South Western Nigeria. Ibadan city lies 3°5' E and 7°23' N. The city is characterized by low level of environmental sanitation, poor housing, and lack of potable water and improper management of wastes especially in the indigenous core areas characterized by high density and low income populations. The vegetation is typically tropic. The climate is characterized by dry November to April and wet May to October seasons. The mean annual rainfall of 1150 - 1500 mm occurs mainly between April and October with the major peak in June. Higher relative humidity (rH) values (rH 80 - 95%) are recorded during the rainy season than the dry season (rH 20 - 50%).

2.2. Isolation of fungi

A total of 18 randomly selected fungal infected fruits and 18 unblemished, healthy and clean looking fruits were purchased (10 each from each market). Fruits were surface sterilized by exposing them in 1 min 90% ethyl alcohol (BDH chemicals Ltd Poole England) and then 3 min to 1% sodium hypochlorite and then rinsed three times in sterile distilled water. Segments (3 - 5 cm) of tissues from the margins of the rotted areas were cut out with a sterile scalpel and placed on previously prepared potato dextrose agar (PDA, Difco; in the case of orange and Pawpaw) and malt extract agar (MEA, Difco; in the case of Tomato) in Petri dishes and incubated at 28 ± 1°C for 5 days under 12 h photoperiod.

2.3. Control Experiment

Each of the fresh fruits was washed and sterilized with 75% ethanol. Then a little portion of each of the fruits was inoculated onto sterile PDA and MEA plates. All plates were incubated at 30°C for 72 hours.

2.4. Identification of Fungi Isolates

The pure isolated fungi were identified using cultural and morphological features according to the most documented keys in fungal identification (Domsch et al., 1993; Klich, 2002; Samson and Varga, 2007). The

isolates were also identified by comparing their characteristics with those of known taxa, as described by Jolt et al. (1994) and Oyeleke and Manga (2008).

2.5. Pathogenicity Tests

This was carried out as described by Baiyewu et al. (2007) and Chukwuka et al. (2010). Each of the fungal isolates was tested on healthy fruits for its ability to induce spoilage. Six healthy fruits (orange, Pawpaw and Tomato) were washed with tap water and rinsed with distilled water after which they were surface sterilized with 75% ethanol. A sterile 4mm cork borer was used to make holes in each of the fruits. A colony of fungi isolate (from each pure culture) was used to inoculate the fruits and the core of the fruits were replaced. The point of inoculation was sealed with petroleum jelly to prevent contamination. Controls consisted of six fruits each of orange, Pawpaw and Tomatoes, wounded with the sterilized cork borer but not inoculated. The inoculated fruits and the controls were placed in clean polyethylene bag (one fruit per bag) each moistened with wet balls of absorbent cotton wool to create a humid environment and incubated at 30 ± 1°C for 5 days. After 72 h, the inoculated fruits were observed for symptom development. The causal agents were re-isolated from the infected Pawpaw fruit and compared with the original isolates. This experiment was replicated three times.

3.0 RESULTS ANALYSIS

Different colonies were observed at the end of the procedure necessary for the isolation and identification of fungi associated with the spoilage of orange, Pawpaw and Tomato. The fungal colonies spoiled the orange, Pawpaw and Tomato fruits causing their deterioration. Mixed colonies were obtained when the fungi were first isolated on potato dextrose and malt extract agar. Pure cultures of the spoilage fungi were observed afterwards when each colony of the fungi was subcultured on freshly prepared medium.

3.1. Observed Symptoms on the Spoilt Fruits

Physically observation of the diseased fruits revealed brownish, necrotic patches on the skin of the orange, Pawpaw and Tomato fruits. The patches were a bit sunken and turned black by the third day in the case of Tomato. The patches on the orange and Pawpaw fruits took 7 days to turn black. A mass of mycelia growing on the surface of the fruits was also observed. Table 1 shows the colonial, morphological and cellular characteristics of the fungi isolated.

3.2. Frequency of Occurrence of Fungi Isolates Associated with the Spoilage of Fruits

The frequency of occurrence of fungi isolates associated with the spoilage of fruits is shown in Table 2. It showed that a total of 9 fungi isolates were obtained from fruits, which were identified as *Aspergillus flavus*, *A. niger*, *Fusarium solani*, *Penicillium digitatum*, *Rhizopus stolonifer* and *Candida tropicalis*. Of which, *Aspergillus niger* species (*A. niger* and *A. flavus*) were the most frequently isolated fungi (33.3%). This was followed by *Rhizopus stolonifer* and *Fusarium solani* with infection rate of 22.2% while *Penicillium digitatum* and *Candida tropicalis* were the least encountered (11.1%) as shown in Table 2. Three fungal species *Aspergillus niger* (50.0%), *Penicillium digitatum* (100.0%) and *Rhizopus stolonifer* (50.0%); were found associated with deteriorating *Citrus sinensis*. *Aspergillus niger* (50.0%), *Aspergillus flavus* (50.0%) and *Fusarium solani* (50.0%) were associated with *Carica papaya*. The mycoflora found associated with *Lycopersicon esculentum* were *Rhizopus stolonifer* (50.0%), *Fusarium solani* (50.0%) and *Candida tropicalis* (50.0%) as shown in Table 2.

3.3. Control Results

Control experiment showed no growth of fungi in the plates of Potato Dextrose Agar (PDA) and Malt

Dextrose Agar (MEA) on which the healthy fruits were inoculated.

3.4. Pathogenicity Test

All the fungi isolates were found to be pathogenic on all fruits. The rot symptoms obtained were similar to those observed previously on the fruits when subjected to identification procedures by examining their morphological, colonial and cellular characteristics. The moulds seen were the same as those of the isolated fungi of fresh fruits which were subject to spoilage. The fruits changed colour slightly after infection and became soft thus could easily be punctured with a finger at the point of inoculation. The pathogenicity test showed that each infected fruit gave the initial organism that caused the spoilage of the fruit. Of all the isolated fungi, *Aspergillus niger* was highly pathogenic leading to rapid disintegration of treated fruits in 3-5 days while *R. stolonifer* and *Fusarium solani* were moderately pathogenic, and *Candida tropicalis*, *Penicillium digitatum* and *Aspergillus flavus* was least pathogenic, and caused the least amount of rot on fruits.

Table 1: Colonial, Morphological and Cellular Characteristics of Fungi Associated with the Spoilage of Fruits

Isolates	Colonial Characteristics	Morphology And Cellular Structure	Organism
O ₁	Colonies velvety yellow, Green.	Conidiophores smooth, relatively short. Penicillia mycelia arranged very irregular and asymmetrical with branches of various lengths. Sparse and irregular metulae with phialides on them, conidia smooth and ellipsoidal.	<i>Penicillium digitatum</i>
O ₂	Colonies light grey, growing extreme rapidly and filling the petri dish with dense cottony mycelia producing mass of sporangia.	A bundle of sporangiophore was formed. Sporangiphore is smooth-walled, aseptate, light brown, simple (arising in groups of 3-5 from stolons opposite rhizoids). Sporangia globose or sub-globose with some flattened base, contained many spores (white at first, then turned black)	<i>Rhizopus stolonifer</i>
O ₃	Colonies with loose white to yellow mycelium rapidly becoming dark brown to black on the development of conidia.	Vesicles light yellow brown. Phialides growing radially along the whole periphery of phialides. Primary phialides and secondary vesicles both are brown.	<i>Aspergillus niger</i>
P ₁	Colonies with loose white to yellow mycelium, rapidly turning dark brown and eventually black on the development of conidia.	Vesicles were light yellow-brown. Phialides growing radially along the periphery of vesicles. Primary phialides and secondary phialides are both brown.	<i>Aspergillus niger</i>
P ₂	Mycelium grey-white with sparse floccose.	Oval microconidia. Microconidia produced on richly branched conidiophores. Cylindrical to facilitate.	<i>Fusarium solani</i>
P ₃	Colonies light green-yellow. At maturity conidia is straw-like and yellow-green.	Conidiophores growing from substrate, hyphae long with thickened finely denticulate wall. Conidia typically radial. Vesicle elongated. Phialides in two layers: primary and secondary.	<i>Aspergillus flavus</i>
T ₁	Shiny, creamy, white colonies.	Single-celled structures	Yeast
T ₂	Colonies light grey, growing rapidly and filling the petri dish with dense cottony mycelium, producing mass of sporangia.	A bundle of sporangiophores was formed. Sporangiphores smooth-walled, aseptate, light brown, simple, arising in groups of 3-5 from stolons opposite rhizoids. Sporangia globose and sub-globose with some flattened base (white at first turning black afterwards) and many spores.	<i>Rhizopus stolonifer</i>
T ₃	Growth moderately rapid, covering agar plate within 4 days with sparse, floccose greyish-white mycelium. A bluish to bluish-brown discoloration developed in the agar.	Oval microconidia produced. Microconidia produced on richly branched conidiophores. Cylindrical to facilitate.	<i>Fusarium solani</i>

Key: O = Orange; P = Pawpaw; T = Tomato

Table 2: Frequency of Occurrence of Fungi Isolates Associated with the Spoilage of Fruits

Isolates	No. (%)	Orange (%)	Pawpaw (%)	Tomatoes (%)
<i>Penicillium digitatum</i>	1(11.1)	1(100.0)	0(0.0)	0(0.0)
<i>Rhizopus stolonifer</i>	2(22.2)	1(50.0)	0(0.0)	1(50.0)
<i>Aspergillus spp. (A. niger & A. flavus)</i>	3(33.3)	1(50.0)	2(50.0)	0(0.0)
<i>Fusarium solani</i>	2(22.2)	0(0.0)	1(50.0)	1(50.0)
<i>Candida tropicalis</i>	1(11.1)	0(0.0)	0(0.0)	1(100.0)
Total	9(100.0)	3(33.3)	3(33.3)	3(33.3)

4.0. DISCUSSION

The findings of this study showed that *Aspergillus flavus*, *A. niger*, *Fusarium solani*, *Penicillium digitatum*, *Rhizopus stolonifer* and yeasts were found in fruits sold in major markets in Ibadan, Oyo State, South Western Nigeria. *Penicillium digitatum*, *Rhizopus stolonifer*, and *Aspergillus niger* were found to be associated with spoilage or deterioration of orange fruits. These pathogens have been reportedly isolated from Pawpaw fruits in Nigeria (Baiyewu et al., 2007; Chukwuka et al., 2010). All the five organisms isolated were confirmed to be pathogenic on the fruits but in varying degrees. It showed that of all the isolated fungi, *Aspergillus niger* was highly pathogenic leading to rapid disintegration of treated fruits in 3-5 days while while *R. stolonifer* and *Fusarium solani* were moderately pathogenic, and *Candida tropicalis*, *Penicillium digitatum* and *Aspergillus flavus* was least pathogenic, and caused the least amount of rot on fruits. When these isolates were aseptically inoculated into healthy susceptible fruits, the characteristic symptoms originally observed were also noticed again. All the five organisms were successfully taking part in the decay and are thus confirmed as the causal organism of fruit decay (Baiyewu et al., 2007; Chukwuka et al., 2010).

Generally, spoiling fungi are considered toxigenic or pathogenic (Al-Hindi et al., 2011). Toxigenic fungi have been isolated from spoiling fruits (Al-Hindi et al., 2011). During refrigeration some moulds may produce mycotoxins (Tournas and Stack, 2001). The fungi isolated in this study have been reported to produce secondary metabolites in plants tissues. These secondary metabolites are potentially harmful to humans and animals (Eaton and Groopman, 1994; Baiyewu et al., 2007). A good example is Aflatoxin which has been associated in cancer of the liver (hepatoma), aflatoxicosis and also with acute hepatitis in humans, especially in the developing world (Krogh, 1992; Prasad, 1992; Eaton and Groopman, 1994; Muhammad et al., 2004; Baiyewu et al., 2007). Pathogenic fungi, on the other hand, could cause infections or allergies (Monso, 2004). *Aspergillus* spp. are known to produce several toxic metabolites, such as malformins, naphthopyrones (Pitt and Hocking, 1997)

and they can produce Ochratoxins (OTA), a mycotoxin which is a very important toxin worldwide because of the hazard it poses to human and animal health (Peraica et al., 1999; Petzinger and Weidenbach, 2002) thus extra care should be taken during personnel handling of these fruits; such as harvesting, cleaning, sorting, packaging, transport and storage (Al-Hindi et al., 2011).

Aspergillus spp. were widespread among all examined spoilage fruits. Several fruit spoilage fungi from different region has been isolated and identified (Al-Hindi et al., 2011). *A. niger* is a fungus commonly found on grapes (Chulze, 2006), apples (Oelofse, 2006) and tomatoes (Yildz and Baysal, 2006). Bali et al. (2008) reported that black mold *A. niger* were caused post harvest spoilage in sweet orange and acid lime at field. Okereke et al. (2010) indicated that the fungi species isolated from the infected mangoes included *A. niger*, *Fusarium* sp and *A. Flavus* and that *Fusarium* sp and *A. Flavus* could not prove pathogenicity when inoculated into healthy mango fruits. The *A. flavus* was investigated by incubating inoculated mango fruits at different temperature showed that at 35°C and 100% relative humidity, *A. flavus* rot severity was maximum (Gadgile and Chavan, 2010; Al-Hindi et al., 2011).

Microorganisms are naturally present on all foodstuffs and can also be brought in by outside elements (wind, soil, water, insects, animals, human handling). They can become contaminated during growing, harvesting and transport of the raw materials, and/or processing into finished products (Lelieveld et al., 2003). It is therefore necessary and important that both the farmer who harvests the fruits into bags for transportation, the marketers and consumers take necessary and appropriate precautions in preventing contamination and eating of contaminated fruits (Baiyewu et al., 2007). This will however reduce the risk of mycotoxins associated with fungi contamination which are deleterious to human health (Baiyewu et al., 2007; Chukwuka et al., 2010).

In this study, *Aspergillus niger*, *Aspergillus flavus* and *Rhizopus stolonifer* were found to be associated with the spoilage of Pawpaw (*Carica*

papaya). This is in agreement with the findings of previous studies. Gupta and Pathak (1986) had earlier reported that *A. niger* and *A. flavus* among others were responsible for post harvest losses in Pawpaw in South Western Nigeria. In consonant with Oyeniyi (1992) who identified *A. niger* isolated from rhizosphere of Pawpaw tree. Baiyewu et al. (2007) had also reported that *Rhizopus nigricans*, *Aspergillus flavus*, *Aspergillus niger* and *Fusarium moniliforme* among others, were responsible for post harvest losses in Pawpaw in South Western Nigeria. Chukwuka et al. (2010) recently reported that *R. nigricans*, *A. flavus*, *A. niger*, *Fusarium sp.*, and *Mucor sp.* were responsible for with Pawpaw fruits decay from a farm in Oyo State, South Western Nigeria. Krogh (1992) has earlier reported that most microbes infecting plant tissues often produced secondary metabolites in their hosts, which are known to be hazardous to animals including man. Fungi associated with Pawpaw roots were studied by Oluma (1992) while Oyeniyi (1992) carried out a survey of microflora in the rhizosphere of Pawpaw. It is however note-worthy to intensify efforts in combating the production constraints associated with Pawpaw fruits spoilage caused by microbes. Researches have shown that the recent disruption of the global food supplies is predominantly due to post-harvest losses associated with microbes (Chukwuka et al. 2010). In line with the assertions of Krige et al. (2006) and Chukwuka et al. (2010), since Pawpaw fruits were usually infected by pathogenic organisms, to be effective, production, preparation and preservation of food such as fruit salads made with Pawpaw must be carried out as rapidly and hygienically as possible using good quality equipment, produce and materials.

In this study, three fungal species *Aspergillus niger*, *Penicillium digitatum* and *Rhizopus stolonifer*; were found associated with deteriorating Orange (*Citrus sinensis*). In a study by Al-Hindi et al. (2011), eighty-three percent of the citrus fruit samples showed fungal growth at levels ranging from 25 to 100% of tested fruits and *Fusarium* spp. were the most common fungi in citrus fruits (Tournas and Katsoudas, 2005). Orange had been studied for fungal decay in storage and its relation to shop (local storage places) and a number of *Aspergillus* spp., *A. nigei*, *A. nidulans*, *A. varicolor*, *A. fumigatus*, *A. Candidus* had been isolated (Sinha, 1946; Al-Hindi et al., 2011). The preponderance of the isolated moulds from Orange (*Citrus sinensis*) belongs to *Aspergillus* species and other genus, and this confirms their prevalence in foods and fruits exposed to tropical humid climate thus constituting potential health risks to consumers of this fruit and it's by products (Niji et al., 1997). *Aspergillus niger* and *Candida tropicalis*. were found associated with deterioration of orange; this is in line with the work of Niji et al. (1997) who reported that *Aspergillus* Sp. is the

predominant organism associated with the spoilage of orange.

In the case of Tomato fruits (*Lycopersicon esculentum*), *Rhizopus stolonifer*, *Fusarium solani* and *Candida tropicalis* was implicated in its spoilage. These agree partly with the findings of Mitra (1997) who discovered that the species of fungi associated with the spoilage of orange, Pawpaw and Tomato fruits include species of *Aspergillus*, *Fusarium*, Yeast, *Penicillium*, and *Rhizopus*. *A. flavus* and *A. Fumigatus* caused tomato spoilage were also investigated by Adisa (1993) and Al-Hindi et al. (2011). Other studies on the fungi associated with tomato rot showed seven fungi associated with fruit rot of tomato including *Fusarium equiseti*, *A. flavus* and *A. niger*, they were all pathogenic on tomato fruits (Oladiran and Iwu, 1993; Al-Hindi et al., 2011). It has been also reported that fungi affecting Tomatoes (*Lycopersicon esculentus*) includes *Fusarium Oxysporium*, *Fusarium moniliforme*, *Aspergillus niger* and *Rhizopus Stolonifer*. They are responsible for Tomato soft rot, as was isolated by Onuegbu (2002) and Akinmusire (2011). Result on the percentage incidence and rot shows that *Rhizopus Stolonifer* caused the greatest rot on tomato fruit. A lot of breeding works have been carried on Tomato up to the point where we now have Tomato hybrids that could withstand adverse environmental condition and are resistant to diseases and pests (Chuku et al., 2008). The isolation of *Fusarium oxysporum*, *Rhizopus stolonifer* and *Mucor* Sp. from tomato confirmed the studies of Efiuvwerwere (2000), Chuku et al. (2008) and Akinmusire (2011) who reported that *Fusarium* Sp, and *Rhizopus stolonifer* is responsible for the soft rot of tomato. Onyia et al. (2005) also reported that *Fusarium moniliforme*, *Aspergillus niger* and *Rhizopus stolonifer* were isolated from rotten tomato fruits.

The results of the pathogenicity tests carried out show that all the organisms were pathogenic and were the actual causal agents of spoilage of the different fruits and can also infect different fruits other than their original host. The tests also established the fact that fungi cause deterioration of the fruits when they gained entrance into them through mechanical injuries such as bruises and wounds as noted by Zitter (1985). *Aspergillus niger* grew at a faster rate than the remaining fungal isolates which was evident in its cause of spoilage in the fruits at a faster rate when compared to the other fungi. *Aspergillus niger* was also noted to appear first on the fruits before the other fungi. Also, the presence of these fungi pathogens in these Pawpaw fruits could pose a serious threat to the health of its consumers.

The isolation of these pathogens confirmed the studies of Gupta and Pathak (1986), Baiyewu (1994), Baiyewu and Amusa (1999), Baiyewu et al. (1994, 2007) and Chukwuka et al. (2010) that *Rhizopus spp.*, and *A. niger* found associated with rotten Pawpaw are highly pathogenic causing appreciable losses in Pawpaw fruits at post harvest. Baiyewu (1994) also isolated *Fusarium spp.*, *A. flavus*, and *Rhizopus spp.* among other pathogens from Pawpaw fruit. In our studies, the pathogenicity analysis revealed that all isolated fungi *A. niger* proved highly pathogenic causing a rapid disintegration of inoculated fruits in three to five days while *R. stolonifer*, Yeasts, *Penicillium digitatum* and *Fusarium sp.* were moderately pathogenic and the least pathogenic was *A. flavus*. However, from the result of this study, *A. flavus* was likely to be a pathogen of Pawpaw fruit but rather contaminants was mostly claimed by Baiyewu et al. (2007) and Chukwuka et al. (2010). Hence, necessary precaution in preventing contamination of this produce by these bacteria and fungi will enhance the microbial quality of the produce (Baiyewu et al., 2007; Chukwuka et al., 2010).

The contamination of fruits and vegetables by fungi could also be as a result of poor handling practices in food supply chain, storage conditions, distribution, marketing practices and transportation (Effiuvwevwere, 2000; Akinmusire, 2011). Post harvest handling and transport of fruit is inadequate (Baiyewu et al., 2007). Therefore most of the fruits harvested do not usually get to the major cities in time due to the nature of transport systems existing in the rural areas. While fruit with bruises are not isolated from the unbruised ones and thereby causing cross-infections, consumers are supplied mostly with partly rotten fruits (Baiyewu et al., 2007). This portends a great risk of aflatoxin and other mycotoxins to the consumers. This is confirmed in a study by Sage et al. (2002) who reported that Aflatoxin M1 was detected in the urine of the Philippine women that consumed peanut butter containing aflatoxin. According to Baiyewu et al. (2007), no tests have been conducted if aflatoxins are in the urine and blood to determine the presence and risk of such metabolites in most working class people in this South Western region of Nigeria. However, the fact that most people have not been diagnosed as having hepatoma or aflatoxicosis does not mean that the toxic metabolite does not exist in their body system (Muhammad et al., 2004; Baiyewu et al., 2007).

The occurrence of fungal spoilage of fruits is also recognized as a source of potential health hazard to man and animals. This is due to their production of mycotoxins (naturally occurring toxic chemical often of aromatic structure) compounds which are capable of including mycotoxicoses in man following ingestion or inhalation. They differ in their degree and manner of toxicity (Effiuvwevwere, 2000; Akinmusire, 2011).

5.0. CONCLUSION

This study detected the profile of spoilage fungi which caused pathogenicity of some local fruits in Ibadan city. It also showed that fungi were involved in the spoilage of many fruits. Mechanical injuries such as bruises or cuts that occur during harvesting or post-harvesting, grading and packing could provide infection sites for spoilage pathogens. Fruit spoilage however can be controlled by the following practices: Washing of harvested fruit with clean or pure water; Proper cleaning and sanitation of warehouses and disinfection of packaging and transit containers; Proper handling of the fruit during harvest to prevent bruises and scars or other mechanical injuries; Inhibition of fungal growth by lowering storage temperatures through storage under refrigeration and the use of fungicides. It is therefore important that both the farmer who harvests the fruits into bags for transportation, the marketers and consumers take necessary precaution in preventing contamination and eating of contaminated fruits. This will however, enhance reduction the risk of aflatoxin and other mycotoxins that are deleterious to human health which are produced by these fungi that have been isolated in this study.

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从诺贝尔化学奖准晶到中国相自旋

-----解密三旋理论 (3)

刘月生

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摘要: 晶体的定义从经典可改写的话, 类此自旋的定义从经典也可以改写。因此, 把自旋定义改写的三旋联系 2011 年诺贝尔化学奖谢赫特曼的准晶或一般的晶体空间群的配位研究, 很有启示。

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<http://www.sciencepub.net>.

关键词: 准晶 自旋 诺贝尔化学奖

2011 年 10 月 5 日瑞典皇家科学院宣布, 以色列科学家达尼埃尔·谢赫特曼因发现准晶体独享 2011 年诺贝尔化学奖。1982 年 4 月 8 日, 谢赫特曼将铝锰合金熔化后快速冷却以防止其结晶, 在电子显微镜下观察到了一张非周期性的原子排列有序但结构模式不重复组合的电子衍射图: 这个合金有非同寻常的旋转对称——五边形对称。在谢赫特曼之前, 应该有许多科学家已经见过这种五次对称图形, 但是因为这不符合晶体学的严格规定, 他们放弃了所见。但 1992 年, 国际结晶学联盟改写了结晶的定义, 从“有序、重复的原子阵列”改为“任何有离散衍射模型的固体”。因这与中国科学家为准晶地位的确立作出的贡献有关, 法国晶体学家格雷迪雅斯这位与谢赫特曼一同发表准晶论文的第三作者, 称中国发现的五次对称钛镍准晶相为“中国相”(China Phase)。

谢赫特曼 1941 年在以色列出生和接受教育, 以色列工学院是他研究事业起步的地方。当 39 年前谢赫特曼发现“准晶体”时, 他面对的是来自主流科学界、权威人物的质疑和嘲笑, 其中包括两届诺贝尔奖获奖者, 美国化学家鲍林就曾措辞强硬地捍卫传统晶体的“纯洁性”。他认为所谓的准晶不过是众人皆知的孪晶, 并公开说: 谢赫特曼是在胡言乱语, 没有什么准晶体, 只有准科学家。但在谢赫特曼艰苦努力和同事布雷希的帮助下, 题为《一种长程有序但不具备平移

对称性的金属相》论文, 发表在 1984 年 11 月的《物理评论快报》, 立即在化学界引发轩然大波。因为当时大多数人都认为, “准晶体”违背科学界常识, 谢赫特曼被斥“胡言乱语”、“伪科学家”。

然而在谢赫特曼发现准晶体后, 科研人员陆续在实验室中制造出其他种类的准晶体。由于原子排列不具周期性, 准晶体材料硬度很高, 同时具有一定弹性, 不易损伤, 使用寿命长。鉴于其“强化”特性, 准晶体材料可应用于制造眼外科手术微细针头、刀刃等硬度较高的工具。此外, 准晶体材料无黏着力并且导热性较差, 其应用范围还包括制造不粘锅具、柴油发动机等, 应用前景广阔。

从谢赫特曼说中国, 我国科学家对准晶研究的这一诺奖成果的验证, 也很早作出过重要贡献。因为到底是准晶, 还是孪晶? 在论战中, 中国科学家为最终达成准周期晶体概念共识, 提供了有力的佐证。这事可追溯至 1956 年, 当时在瑞典工作的著名冶金专家郭可信先生回到祖国, 先后赶上“大跃进”和“文化大革命”, 到“文革”结束, 已年近 60 岁的郭可信敏锐捕捉到, 利用高分辨率电子显微术进行合金相研究的国际热潮。1980 年, 在中国科学院金属研究所工作的郭可信, 向中科院领导申请引进当时最为先进的 JEM200CX 高分辨率电子显微镜, 到 1981 年秋天, 郭可信的申请得到批准。1984

年,他带领的团队在高温合金中分离出来的 Laves 相、Frank-Kasper 相及 C 相的单晶衍射图中,都发现有五次对称分布的强斑点。郭可信又安排研究生张泽(现中国科学院院士)进行钛镍合金实验,另一名研究生蒋维吉开展镍钴合金实验。

1984 年 11 月,张泽在中科院金属所的高分辨率电子显微镜下,得到五次对称的电子衍射图;郭可信让张泽在 1985 年春节探亲期间,去上海硅酸盐所进行大角度倾斜实验。此时,郭可信看到了谢赫特曼发表在《物理评论快报》上的论文,并把情况告知远在上海的张泽。1985 年 2 月,张泽在钛镍合金中如期发现了五次对称准晶。与此同时,蒋维吉也在急冷的镍钴合金中得到了五次对称电子衍射图。1985 年,张泽为第一作者的准晶研究论文《一种具有 20 面体点群对称的新相》、蒋维吉为第一作者的孪晶研究论文《急冷镍钴合金的十重孪晶》,同时发表在英国《哲学研究 A》杂志上。

郭可信带领团队一举将中国的准晶和电子显微研究带入了世界前列,并在随后的 20 多年中,一直与美国和日本并列“准晶研究三雄”。2006 年 12 月,郭可信先生与世长辞。如果说中国为准周期晶体概念达成共识作出的贡献,被国际称为“中国相”,我们感到骄傲。但从谢赫特曼准晶到中国相,我联想到中国相与自旋的关系,感到自旋的定义实际也需要改写。而且我国在自旋概念定义的改写上,也许达到了类似谢赫特曼的贡献,然而国内并没有达成共识。在对自旋定义的改写上,类似物理权威人物中科院何祚庥院士,在成都答四川省科普作协董仁威主席问时,就斥之为“伪科学”。

如果说晶体的定义,从经典的“有序、重复的原子阵列”定义,可改写为“任何有离散衍射模型的固体”的话,类此,自旋的定义从经典的类似“对称有序、重复完整的动量阵列”定义,可改写为“任何有离散衍射对称有序重复模型的动量”。而从含五次对称晶体构造配位,对应平面的正五边形绕

中心点的内接正五边形的旋转构造配位,再回到对应立体的五次对称准晶格构造,配位数为 12 的配位多面体有三种基本形式,立方八面体配位、六方最紧密堆积配位和二十面体配位。其最稳定的二十面体配位,就体现是稳定的有离散衍射对称有序重复模型的准自旋意义的话,那么也联系相因子。

相因子类似分形、分维式的准自旋,被数学家用来演示群论,在物理学、化学、生物学、矿物学和数学等领域创造的多种多样群论描述的相因子,发挥了石破天惊的作用。而中华民族的见微知著、取类比像的本领,正是在相因子这种准自旋相的现代科学研究上,能发挥极致。这第一次的突破,就是杨振宁院士 1953 年还在芝加哥读研究生时,就注意到电荷守恒理论与在相因子变换下拉氏量的不变性。1954 年杨振宁和米尔斯提出非交换规范场论,把外尔(Weyl)规范理论中的相因子推广到李群中的元素。

1964 年 2 月毕业于北京钢铁学院物理专业,随后到中科院金属所攻读研究生,在郭可信先生指导下从事晶体缺陷的电子衍射衬度象、1987 年国家自然科学奖一等奖荣获者的叶恒强,曾任中国科学院金属研究所所长,当年在金属所负责指导准晶研究工作,现已是中国科学院院士、中国电子显微镜学会理事长、北京大学物理学院教授,在分享准晶发现的酸甜苦辣和探讨准晶发现的意义与价值时说:“我们的发现是独立的,并且与谢赫特曼的研究属于不同的研究体系。”在叶恒强看来,重大科学发现的机遇往往出现在各方条件都已成熟之时,准晶在上世纪 80 年代初的发现,由于得到了国家的支持,当时的中国科学家并未受到仪器设备方面的太多制约,而在理论和社会需求方面,确实和美国等还有差距。

但我国准晶研究,总的说来还是幸运的。彭思龙先生在博文中说,只要一个国的家在某一个领域形成了垄断,那么对于打破这个垄断的技术研究往往会持排斥态度。美国垄断了世界上的能源,俄罗斯有用不完的

自有能源,都需要解决能源问题。军事能力从来都没有退出国家间的关系的核心位置,而科学研究才是军事技术的主要支撑。所谓真正无国界的科学领域,只有那些人类最基础的原理性知识,包括基础数学、理论物理等领域,没有直接的工业应用,原理突破技术还需要跟上。但即便是数学这样的基础领域,也是具有国家利益的。这个在航天等领域表现非常的明显,发动机或者机身的设计本质上除了材料,外形设计就是数学模型和计算问题,这些问题很难说是数学的进步,还是工业的进步。再如密码领域,一个进展可以使得一个国家的保密能力提高很多,有些国家对这方面的进展不会及时公布世界的。

彭思龙先生说,不具有国家利益的基础性知识,发明人和其所在国家不会因此就隐瞒了这些理论,只能公布于世。但也往往成为垄断等人物斥之为“伪科学”,追打的对象。相因子准自旋对自旋定义的改写,是不是“伪科学”?这可以对自旋先作语境分析,并用对称概念,对自旋、自转、转动作语义学的定义:

(1) 自旋:在转轴或转点两边存在同时对称的动点,且轨迹是重叠的圆圈并能同时组织起旋转面的旋转。如地球的自转和地球的磁场北极出南极进的磁力线转动。

(2) 自转:在转轴或转点的两边可以有或没有同时对称的动点,但其轨迹都不是重叠的圆圈也不能同时组织起旋转面的旋转。如转轴偏离沿垂线的陀螺或迴转仪,一端或中点不动,另一端或两端作圆圈运动的进动,以及吊着的物体一端不动,另一端连同整体作圆锥面转动。

(3) 转动:可以有或没有转轴或转点,没有同时存在对称的动点,也不能同时组织起旋转面,但动点轨迹是封闭的曲线的旋转。如地球绕太阳作公转运动。

那么类圈体应存在三类自旋,现给予定义:

(1) 面旋:指类圈体绕垂直于圈面中心的轴线作旋转。如车轮绕轴的旋转。

(2) 体旋:指类圈体绕圈面内的轴线作旋转。如拨浪鼓绕手柄的旋转。

(3) 线旋:指类圈体绕圈体内中心圈线作旋转。如地球磁场北极出南极进的磁力线转动。

所以从上三旋可见,这是一个孺幼皆知能明白的自旋客体操作规范,是一种“真科学”。而且由两条单链的圈子编码组装的孤子链,还可以直接演示“1/2自旋”的图像。同时体现物质也可以是一种能量和信息的传输巡行,它们给出了所谓的“力”和奇异性,存在于交叉信道的一个极点上的直观说明演示。一般假定,李群是一个光滑的流形,以上自旋改写的非标分析,三旋也类似一种李群,即它是光滑的,又含有群。

把自旋定义改写的三旋联系2011年诺贝尔化学奖谢赫特曼的准晶或一般的晶体空间群的配位研究,例如对晶体空间群的230种分类,也很有启示。原因是准晶或一般的晶体的复合时空,实际讲的是外部空间230个晶体空间群分类,这种外部空间多样性还是以外在的球面几何结构作的基础,并没有涉及环面几何结构问题。即晶体空间群结构主要是以球面拓扑单元作的基础。因此 $a_1, a_2, a_3, \beta, \lambda$ 的可正可负是作为外部时空手征性的五重双共轭编码出现的,其中 a_1, a_2, a_3 为空间三维坐标的线度, β 为与时间相关的线度, λ 为与质量相关的线度。其具体操作如下:

1、230个晶体空间群思维可追溯到古希腊时代,当时柏拉图和欧几里德就已经证明,空间用正多面体无缝隙连续堆积只有五种:正四面体,正八面体,立方体,正十二面体和正二十面体。正是这个几何学上的成就,促使人们认真仔细地去对晶体的图形和面角、棱角进行精确的测量,从而开始考虑用群论的数学方法对晶体进行分类。

2、按照有限群论,在数学上只能推引出219个空间群,但大量晶体的分类表明,

有那么 11 个群，有对映群。即若对那 11 个群，在定义对称元时用三维空间的左手坐标系，由于空间手征性相反，对它们的对映对称元，则应用右手系。实验表明，它们确实是两种不同的物质，具有很不相同的物理以及生理功能。于是在 219 个群之上理应再加上 11 个，即得到了 230 个晶体空间群。俄国晶体学家费多罗夫用群论，首先推引出 219 个空间群，并且发现其中有 11 个群皆有其对映群。

3、以上每一对对映群中的两个群，具有相同的群元，只是在定义它们的群元时，一个群用左手三维空间坐标，另一个则用右手三维空间坐标。也就是它们是不同的，是可以分辨开的两个群。于是空间群的总数应为 $208+11\times 2=230$ 。 $a_1, a_2, a_3, \beta, \lambda$ 的引入，是在用群论方法对物质进行分类研究成功之后，反思研究 230 空间群，更感必然涉及时空手征性，即时空变换群。这属连续群。这等于引用一种二重的三维空间，其中一个为左手系，另一个为右手系。对于简单空间群，可写成平移群与一点群的直积，并把点群归结于晶体本身的特征。从而这些晶体的时空特征，具有伽里略时空的性质。

4、但是对于非简单空间群，不能这样做。这时所用的时空，其变换群应把作为其离散子群。当晶体外延时，不是对时空变换的一个真子群。把三旋的五维时空推证与前面 $a_1, a_2, a_3, \beta, \lambda$ 五个宇宙参数对应，不难看出三旋的三个直角坐标维数与 a_1, a_2, a_3 对应，时间一维与 β 对应，剩下的一个空间圈维与 λ 对应。但 λ 是与物体的质量有关的，进而也与物体的能量、信息有关。

这说明三旋的圈维与物体的质量，进而也与物体的能量、信息对应。反之，物体的质量或能量、信息即与空间圈维有关。这就三旋理论揭示的时空与物质相联系、同结构的秘密。

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Physico-chemical and bacteriological analysis of water samples used for domestic purposes in Imesi-ile, Osun State, Southwest Nigeria.

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Abstract: One of the Millennium Development Goals is reducing the proportion of people without access to safe drinking water by 50%. Majority of the rural populace in Nigeria do not have access to pipe borne water but depend on ground water for domestic uses. Samples of water used for domestic purposes were collected from wells from different locations in imesi-ile. The physico-chemical and bacteriological analysis were done using standard methods and the results were compared with WHO and FMENV standards for drinking water. The pH ranged from 5.2-7.1, temperature was 26.1⁰C, electrical conductivity ranged from 49 to 1118 μ Scm⁻¹, total dissolved solids ranged from 24 to 559 mg l⁻¹, total hardness ranged from 6.01 to 46.08, nitrate ranged from 2.6 to 20.8, manganese ranged from 2.6 to 20.8, potassium ranged from 0.783 to 39.51, sodium ranged from 56.4 to 72.79, lead ranged from ND to 0.04, cadmium ranged from 0.05 to 0.062, copper ranged from ND to 0.10 and zinc ranged from 0.04 to 0.016. The bacteriological parameters analysed were total viable count which ranged from 1.75 x 10³ to 1.81 x 10³ cfuml⁻¹. Bacteria isolates were identified as *Proteus sp*, *Bacillus sp*, *Escherichia coli*, *Pseudomonas sp*, *Salmonella sp*, and *Staphylococcus aureus*. Even though most of the physico-chemical parameters are within the FMENV and WHO permissible limits, the total viable count for all samples exceeded the WHO and FMENV standards. The coliform counts for some samples were within acceptable limits but others exceeded the WHO permissible limit for drinking water making the water unfit for drinking and other domestic purposes without prior treatment.

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Key words: Physico-chemical parameters, bacteriological analysis, domestic purposes

1. Introduction.

Assessment of the quality of drinking water is important for sustainable development. In many developing countries, availability of water has become a critical and urgent problem for communities without access to pipe borne water (Okonko et al, 2008). There is need to control the pollution of surface and ground water since the public health of the people have a direct link with the availability of adequate quantity of good quality water (Alao et al, 2010). Potable water is the water that is free from disease producing microorganisms and chemical substances that are dangerous to health (Lamikanra, 1999). Majority of the rural populace do not have access to potable water but depend on wells, streams and river for domestic use. One of the Millennium Development Goals is to reduce the proportion of people without access to safe drinking water by 50%, yet rural communities are the furthest from meeting the 2015 MDGs drinking water target (The Millennium Development Goals Report). Rural settlements in Sub-saharan Africa have made the least progress in improved water sources since 1990, improving only by 9% in 2006.

In recent years, ground water has been under increasing threat of pollution due to increased human activities (Jameel, 1998). The cleanliness of lakes, rivers, oceans and ground water is one of the most pressing goals of environmental protection. The World Health Organization has recommended continuous surveillance of water supplies; this involves keeping a careful watch at all times, from public health point of view, over the safety and suitability of water supplies. The lack of safe drinking water and adequate sanitation measures can cause diseases such as cholera, dysentery, salmonellosis and typhoid, and every year they claim millions of lives in developing countries. Diarrhoea is the major cause of death of more than 2 million people per year world-wide, mostly children under the age of five (Anon 2000). Throughout the world, about 2.3 billion people suffer from diseases linked to water related problems (UN, 1997, WHO, 1997)

The scarcity of pipe-borne water has made many communities to find alternative sources of water: ground water sources being a ready source. For most communities the most secure source of safe drinking water is pipe-borne water from municipal water treatment plants. Often, most water treatment

facilities do not deliver or fail to meet the water requirements of the served community; due to corruption, lack of maintenance or increased population (Adekunle, 2009). Water quality monitoring involves physicochemical and bacteriological analyses of water samples from various sources. Microbiological quality of water is of greatest importance especially in developing countries with low standard of sanitation. This aspect includes routine sampling and analysis of drinking water to ensure that it does not contain coliform bacteria an indicator of pollution with excreta. *Escherichia coli*, Faecal coliforms and *Aerobacter aerogenes* are among the common indicators. In Nigeria, majority of the rural populace do not have access to potable water but depend on wells, streams and rivers for domestic water supply (Lamikanra, 1999). The bacterial qualities of groundwater and other natural water supplies in Nigeria, have been reported to be unsatisfactory, with coliform counts far exceeding the level recommended by W.H.O (Dada *et al.*, 1999a, 1999b, Edema *et al.*, 2001) Chemical investigation of the water quality of some Nigerian rivers.(Ajayi and Osibanjo, 1981; Adeniji and Mbagu, 1983; Imevbore, 1970; Asuquo, 1989) reveals that water that was once an abundant natural resource is rapidly becoming scarce in quantity and the quality is deteriorating in many places, owing to population. Imesi-ile, a town in Nigeria depends on wells for most its' domestic water supply. To the best of our knowledge, there are no reports on the sanitary quality of well water from this area. This study was undertaken to evaluate the physicochemical and bacteriological analysis of water used for domestic purposes in this area.

2. Material and Methods.

Study Area

The study area, Imesi-ile, Osun State, Southwest Nigeria. It is situated on Longitude 4° 49'

60 E and Latitude 7° 49' 60 N. Water samples were collected from wells in selected locations.

Quality Assurance Procedures

Samples analysed for DO (dissolved oxygen) and COD (chemical oxygen demand) were collected using glassware while heavy metals and other parameters were collected in plastic containers. The plastic and glass containers were soaked in 1M HNO₃ overnight (Onianwa, 2001) and washed with laboratory detergent, rinsed with tap water and finally with deionized water.

Physico-Chemical Analysis

The physico-chemical parameters analyzed in accordance to standard methods of [APHA, 1998] were pH, temperature, electrical conductivity, total dissolved solids, total hardness, Ca²⁺ hardness, Mg²⁺ hardness, nitrate, manganese, potassium, sodium, lead, cadmium, iron, copper and zinc.

Bacteriological analysis

The membrane filtration method of water analysis was employed. Membrane filters of 0.45µm pore size with diameter of 47mm were used in line with recommendations by APHA – AWWA, 1998. Each membrane filter was inoculated on sterile petri dishes containing media for culturing certain indicator bacteria. Baird Parker agar, Salmonella-Shigella agar, McConkey agar, Eosin methylene blue agar, Pseudomonas centrimide agar, Mannitol salt agar and plate count agar were used for enumeration of bacteria and the primary identification of some of the isolates. The media were prepared according to manufacturers' specification and sterilized in an autoclave at 121°C for 15 minutes. Pure culture of bacteria isolates obtained from inoculated plates was further subjected to morphological characterization tests to determine their identity in accordance with Bergey's Manual of Determinative Bacteriology. (Buchanan and Gibbon, 1974).

3. Results

Table1. Physicochemical parameters of water samples

Parameters	W1	W2	W3	W4	WHO	FMENV
Temperature (°C)	26.1 ⁰ C	26.1 ⁰ C	26.1 ⁰ C	26.1 ⁰ C		
pH (mg ^l ⁻¹)	6.5	5.2	7.0	7.1	6.5-8.5	6.5-8.5
Conductivity (μScm ⁻¹)	223	49	1118	328	300	
TDS(mgl ⁻¹)	120	24	559	163	500	500
Total Hardness(mgl ⁻¹)	105.67	101.12	210.56	58	100	100
COD	8	-	-	-	10	-
BOD	13	-	-	-	-	-
DO	3.2	-	-	-	5	-
Calcium Hardness	44.75	5.15	43.78	18.82	100	75
Magnesium Hardness	1.33	0.86	12.76	3.03	150	30
Nitrate(mgl ⁻¹)	2.6	5.03	20.80	10.40	10	10
Cadmium(mgl ⁻¹)	0.046	0.062	0.062	0.04	0.05	0.01
Iron(mgl ⁻¹)	0.034	0.394	0.030	0.089	0.3	0.3
Zinc(mgl ⁻¹)	0.016	0.040	0.040	0.016	5.0	5.0
Lead(mgl ⁻¹)	ND	ND	0.062	0.078	0.05	0.05
Copper(mgl ⁻¹)	0.01	0.005	ND	0.005	1	0.1
Manganese	0.009	0.013	0.008	0.003	0.1	0.05
Sodium	62.66	56.40	72.79	59.84	200	20
Potassium	0.838	0.783	39.514	14.118	12	-

W1, W2, W3 and W4 are water samples from wells from different locations.

WHO: World Health Organization, FEPA 1991/ FMENV: Federal Ministry of Environment (Nigeria)

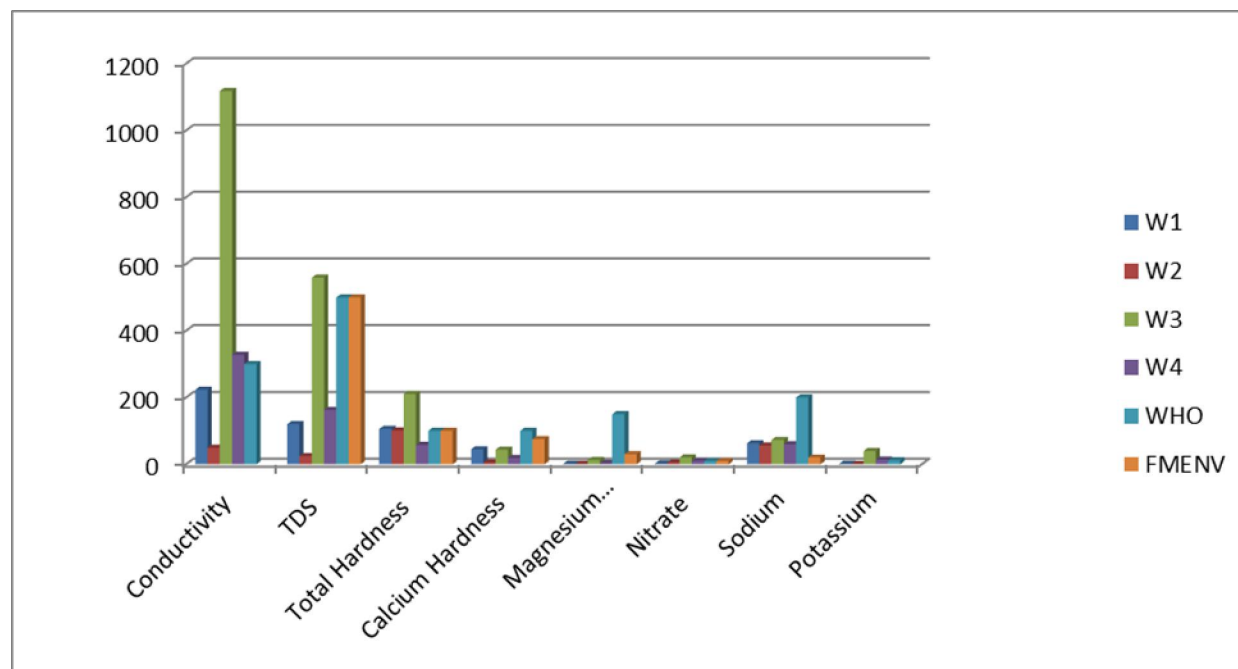


Figure 1. Physicochemical parameters of water samples

Table 2. Sample count after 48hours on incubation on the media.

Sample	TBC(cfu/ml)	Coliform count(cfu/100ml)	Pseudomonas count (cfu/ml)	EMB(cfu/ml)
W1	1.79×10^3	-ve	-ve	-ve
W2	1.78×10^3	1.1×10	2×10^2	3.1×10^2
W3	1.81×10^3	0.5×10	-ve	0.11×10^2
W4	1.75×10^3	-ve	-ve	-ve

Table 3. Morphological characteristics of isolates

Bacteria isolates	Characteristics	Probable organism
A	Gram positive rod with creamy colony on nutrient agar. Spore present	Bacillus species
B	Gram negative fat rod. Colony with entire margin with mucoid constituency. No spore. Gave metallic sheen colonies on EMB agar. Motile	E. Coli
C	Gram negative rod, non motile colonies appear translucent in on Nutrient agar with feather shaped margins	Proteus sp.
D	Gram negative rod with no spore. Rods are short. Appear colourless on Nutrient agar. Appeared with yellowish colony on Pseudomonas centrimide agar after 48 hours	Pseudomonas sp.
E	Gram negative rod with dark centered colony. Non endospore form grew on Salmonella Shigella agar	Salmonella sp.
F	Gram positive cocci with no spore or motility	S.aerus, staphylococcus sp.

4. Discussion

The results as listed in Table 1 showed that the pH, temperature, calcium, magnesium, sodium and potassium were within the permissible limits of WHO and FMENV. Nitrate concentration for sample 1 and 2 were within the WHO limits but sample 3 and 4 exceeded the limits. Nitrate contamination result from human activities such as agricultural fertilizer, animal waste or seepage from septic tank (Schubert et al, 1999). Conductivity was measured as $\mu\text{S}/\text{cm}$ and ranged from 49 to 1118; sample 3 had the highest value, suggesting that the dissolved solids are mostly mineral salts. The WHO has suggested a limiting value of 500mg/L of TDS for potable water. In the present study samples complied with this limit except sample 3 which was 559. Total hardness for sample 3 and 4 exceeded the standards set FMENV and WHO. All the wells from which the samples were taken had concrete ring except for sample 3, making contamination by seepage from surrounding soil more likely. This probably explains why some of the parameters for sample 3 had higher values when compared with other samples. Dissolved oxygen present in drinking water adds taste and it is highly fluctuating factor in water. In this study dissolved oxygen for sample 1 was 3.2 which was within the WHO limits. The maximum allowed value of chemical oxygen demand (COD) is 10 mg/L in drinking water similarly for sample 1 the COD was 8 mg/L and this was also within the WHO permissible limit. Cadmium in sample 2 and 3 was higher than the WHO and FMENV permissible limits whereas the

heavy metal concentration for the other samples were within the permissible limits.

Water from the wells fall short of the WHO (1997) recommended guideline standard for drinking water in terms of the coliform counts. Contamination of wells is due to improper construction, shallowness, animal wastes, proximity to toilet facilities, sewage, refuse dump sites, and various human activities around the well (Bitton, 1994). Water intended for drinking should not contain any coliform indicative of faecal contamination. The microbial load of well water close to refuse disposal site has higher microbial count than the one far away from refuse disposal site. (Shittu et al, 2008). Results of bacteriological analysis of water sample is presented in Table 2. The coliform count for sample 2 exceeded the WHO standard for untreated water while sample 2 was within the limit, this shows that the well from which sample 2 was taken may be located close to a refuse dump or septic tank. Also the total viable count for all water samples were quite high ranging from 1.75×10^3 to 1.8×10^3 cfu/ml⁻¹. This is higher than the WHO standard zero cfu /100ml, (WHO 2002) for drinking water. Bacteria isolates were identified as *Proteus sp*, *Bacillus sp*, *Escherichia coli*, *Pseudomonas sp*, *Salmonella sp*, and *Staphylococcus aureus* as shown in Table 2 and 3. These findings are in line with a previous study of Ali *et al*, 2007. The high bacteria count is suggestive of presence of organic matter (Olayemi, 1994). This makes the water undesirable because of the increased likelihood that pathogens may be present.

5. Conclusion

The study revealed that the quality of water samples was acceptable for majority of the physico-chemical parameters, but bacteriological analysis shows that the water is not coliform free and must be treated before it is used for domestic purposes. We therefore recommend that the inhabitants of Imesi-ile should not use their water supplies for drinking without boiling or appropriate treatment measures are employed, along with this there should be regular monitoring of groundwater quality. We also recommend that wells should be properly constructed and must not located close to septic tank, sewage or refuse disposal site.

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超导量子信息技术机理和弱力应用

——解密三旋理论 (2)

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摘要: 在超导材料和超导信息技术的设计和实验中, 超导量子传输机理实现的难点真正在哪里? 现讨论用超导、量子比特、弱力和孤子链实现共轭信息传输和超导量子信息技术。

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关键词: 超导材料 量子技术 隐形传输 弱力 孤子链

1993年, 美国物理学家贝尼特等人提出了“量子态隐形传输”的方案。2004年, 美国和奥地利的物理学家实现了原子间的量子态隐形传输。从一般的通信、信号发展到全新通信方式的超导量子通信网络, 在信息技术和高铁技术中已属于基础科学技术和前沿科学技术。目前由中国科大和清华大学实现的世界上最远距离的量子态隐形是16公里, 这已经比原世界纪录提高了20多倍。我们在超导量子信息技术及传输方面的研究工作和工程设计也取得了根本突破和技术成果, 走到了国际前沿, 也是我们为之奋斗的“中国制造、中国创意、中国设计、中国科学”指导思想的具体实践。这里只就超导量子信息技术机理和弱力应用原理作一些讨论。

一、超导材料技术机理与超导信息

众所周知, 研究超导和量子隐形传输在国内外都是基础和前沿研究, 超导量子隐形传输仅有理论不行。我们在超导量子信息技术及智能计算机等一系列研究工作中, 多年来做了大量的实验和创新, 精益求精地做成相关的技术设备和合格产品。

1、一切的理论, 都必须落实到基础的信息技术设备和元件的生产上, 制造超导信息技术器件要明白超导和弱力能源原理在此的应用和突破。国内在超导量子方面, 中科院、中科大、清华大学、南京大学、复旦大学等有不少成果。我们在这方面也做了大量的研究工作和工程设计。

1) 超导材料和元器件: 任何物质都是在一定的物理条件(包括温度、压强和电磁场等)下形成并存在的。拓展物理实验条件到极端状态, 可以形成许多在常规条件下不能得到的新物态; 极端条件可以拓展物质科学的研究空间, 为解决当前许多重大科学技术中的疑难问题, 发现许多在常规条件下不会出现的新现象, 从而拓展我们认识自然、改造自然和造福人类的能力, 为解决当前许多重大科学技术中的疑难问题, 以及创造新物态、合成新材料、发现新现象提供前所未有的机遇。例如, 某些金属、合金和化合物, 在温度降到绝对零度附近某一特定

温度时, 它们的电阻率突然减小到无法测量的超导现象, 是一个宏观量子现象, 其发生超导现象的物质叫做超导体。

零电阻是超导体的基本特征, 超导体还是一个完全的抗磁场体。寻找超导材料方法主要两类, 一类是混合数种金属的冶金学方法, 一类是以绝缘体为主体材料混入不纯物的化学方法, 其铜氧化物高温超导材料最具代表性。2011年日本东京大学和东北大学等研制超导材料, 是利用电场效应使绝缘材料具有超导性另一种新手段, 它能够使钽酸钾这样的原先认为不能成为超导材料的物质拥有超导性。这也能启发寻找类似隐形传输芯片具有更高临界温度的超导新材料研制。他们的办法是, 选择化学性质非常稳定、几乎不含任何杂质的钽酸钾作为绝缘材料, 然后将固体绝缘材料放置在一种含离子的液体中, 绝缘材料表面会自发形成双电层。在这种电场效应下, 绝缘材料具有了超导性, 在温度零下273.1摄氏度的环境下实现了零电阻。

超导体由正常态转变为超导态的温度, 称为这种物质的转变温度(或临界温度) T_c 。现已发现大多数金属元素以及数以千计的合金、化合物都在不同条件下显示出超导性。如钨的转变温度为0.012K, 铋为0.75K, 铝为1.196K, 铅为7.193K。由镧、铈、铜、氧组成的陶瓷材料在14℃温度下存在超导迹象。超导元素加入某些其他元素作合金成分, 可以使超导材料的全部性能提高。如最先应用的铌锆合金(Nb-75Zr), 其 T_c 为10.8K, H_c 为8.7特。继而发展了铌钛合金, 虽然 T_c 稍低了些, 但 H_c 高得多, 在给定磁场能承载更大电流。其性能是 Nb-33Ti, $T_c=9.3K$, $H_c=11.0$ 特; Nb-60Ti, $T_c=9.3K$, $H_c=12$ 特(4.2K)。目前铌钛合金是用7~8特磁场下的主要超导磁体材料。铌钛合金再加入钽的三元合金, 性能提高, Nb-60Ti-4Ta的性能是, $T_c=9.9K$, $H_c=12.4$ 特(4.2K); Nb-70Ti-5Ta的性能是, $T_c=9.8K$, $H_c=12.8$ 特。在常压下有28种元素具超导电性, 其中铌(Nb)的 T_c 最高, 为9.26K。超导元素与其他元素化合常有很好的超导性能。如已大量使用的 Nb3Sn, 其

$T_c=18.1\text{K}$, $H_c=24.5$ 特。其他重要的超导化合物还有 V_3Ga , $T_c=16.8\text{K}$, $H_c=24$ 特; Nb_3Al , $T_c=18.8\text{K}$, $H_c=30$ 特。在镧—钽—铜—氧化物中发现了 $T_c=35\text{K}$ 的超导电性。钽—钽—铜氧化物中发现 T_c 处于液氮温区有超导电性。加拿大和德国的科学家共同合作, 通过在高压下对硅烷(一种富氢化合物)进行作用, 发现了一种作为超导新材料——分子氢化物。

周廉院士研究小组攻克高均匀 NbTi 合金熔炼技术和二硼化镁超导线材研究高 J_c 线材制备技术难关, 这一成果被国际超导界权威誉为“开创了高临界电流密度铌钛超导体研究的新纪元”, 使钽钨铜超导体材料的电学性能超越了世界纪录。超导材料制作通信电缆和天线, 其性能优于常规材料。用超导材料的约瑟夫森结作计算机的逻辑和存储元件, 其运算速度比高性能集成电路的快 $10\sim 20$ 倍, 功耗只有四分之一。用超导材料的约瑟夫森效应, 可制作一系列精密测量仪表以及辐射探测器、微波发生器、逻辑元件等。

2) 超导体在强磁场中机理: 研究侧重于正常态在强磁场下的磁阻、霍尔效应、涨落效应、能带结构、费米面的性质以及 $T < T_c$ 时用强磁场破坏超导达到正常态时的运输性质, 有机(包括富勒烯)超导体在磁场中的运输和载流子特性, 混合态区域的磁通线运动, 不可逆线性性质、起因及其与磁场和温度的关系, 临界电流密度与磁场和温度的依赖关系及各向异性; 强磁场下二维电子气中非线性元激发的特异属性, 低维磁性材料的相变和磁相互作用, 强磁场下的低维凝聚态特性; 低维性使得低维体系表现出三维体系所没有的特性, 低维不稳定性导致了多种有序相等。

强磁场是揭示低维凝聚态特性的有效手段。在强磁场下研究二维电子气的输运现象时, 发现了量子霍尔效应和分数量子霍尔效应(获 85 年诺贝尔奖)。超导材料的物理状态, 改变角动量(自旋)和带电粒子的轨道运动, 也就改变了物理系统的状态。磁场可以产生新的物理环境, 并导致新的特性; 低温也能导致新的物理状态, 如超导电性和相变, 但强磁场极不同于低温, 它比低温更有效。这是因为磁场使带电的和磁性粒子的远运动和能量量子化, 并破坏时间反演对称性, 使它们具有更独特的性质。带电粒子象电子、离子等以及某些极性分子的运动, 在磁场特别是在强磁场中会产生根本性变化。强磁场可以在保持晶体结构不变的情况下改变动量空间的对称性, 这对固体的能带结构以及元激发及其互作用等研究是非常重要的。

固体复杂的费米面结构正是利用强磁场使得电子和空穴, 在特定方向上的自由运动从而导致磁化和磁阻的振荡这一原理而得以证实的。固体中的费米面结构及特征研究, 一直是凝聚态物理学领域中

的前沿课题。当今凝聚态物理基础研究的许多重大热点都离不开强磁场这一极端条件, 甚至很多是以强磁场下的研究作为基础。如波色凝聚只发生在动量空间, 要在实空间中观察到此现象必需在非均匀的强磁场中才得以可能。强磁场应用于材料科学为新的功能材料的开发另辟新径, 从而促进凝聚态物理学的进一步发展和完善。由固体物理学演化为凝聚态物理学, 从周期结构延伸到非周期结构, 从三维晶体拓宽到低维和高维, 乃至分数维体系。这些新对象展示了大量新的特性和物理现象。

在极微细尺度体系中出现许多常规材料不具备的新现象和奇异特性, 这与这类材料的微结构特别是电子结构密切相关。强磁场为研究极微细尺度体系的电子态和输运特性提供强有力的手段, 不但能进一步揭示这类材料在常规条件下难以出现的奇异现象, 而且为在更深层次下认识其物理特性提供丰富的科学信息。要研究强磁场下极微细尺度金属、半导体等的电子输运、电子局域和关联特性; 量子尺寸效应、量子限域效应、小尺寸效应和表面、界面效应; 以及极微细尺度氧化物、碳化物和氮化物的光学特性及能隙精细结构等, 是因为在各种物理因素中, 外磁场是唯一在保持晶体结构不变的情况下, 改变动量空间对称性的物理因素。通过对强磁场下半导体材料的光、电等特性开展实验研究, 可进一步理解和把握半导体的光学、电学等物理性质, 从而为制造具有各种功能的半导体器件并发展高科技作基础性探索。

3) 材料、线路蚀刻操作技术和图灵原理的功能实现: 信息传输元件、芯片的线路, 用激光的光蚀刻技术改变一个原子的状态, 以及用激光冷却将原子保持操作的可靠性, 已经是一项很先进的尖端科学技术。但这一项很成熟的技术, 正如光蚀刻工艺只是一种与制造印刷电路板类似的工艺, 原理是将零件图像通过紫外线曝光而传输到涂有光刻胶的金属上, 未曝光的光刻胶被冲洗掉, 留下需要蚀刻的裸金属; 在蚀槽法蚀刻中, 将准备好的板浸没在蚀刻剂中; 在传送带法蚀刻中, 在板的上下表面喷上高压蚀刻剂; 由金属的合金和厚度确定在蚀刻剂中的曝光长度一样, 在量子隐形传输元件、芯片的生产中还是原始的。由它扩展的一些技术也同样。如纳米蚀刻技术、触摸屏线路激光蚀刻技术、光流控技术等。

说来光流控学已是将微流控技术与微型光学器件交叉集成的一门新兴学科, 但量子隐形传输元件有“芯片上的实验室”之称, 因为它是将各种量子信息实验集成在一块小芯片上的, 以上技术还难以突破。例如光流控技术虽然能为在芯片平台上产生、控制以及处理光信号提供了一种独特的解决方案, 可以应用于光刻、光开关和光学成像领域。它的核

心是发展出基于聚二甲基硅氧烷 (PDMS) 弹性高分子材料的微镜芯片。在这种芯片中, 利用灌入一个个由 PDMS 薄膜构成的微腔中以形成微镜, 通过多层软光刻技术研制出一种具有大变焦比和焦距高精度可调的液体复合微透镜集成芯片, 可解决光流控微透镜很多棘手问题, 但它与多粒子量子纠缠态隐形传输思路相去甚远。

其道理是, 多粒子量子纠缠态隐形传输是要造就多粒子量子能相互“交谈”环境的技术, 这是类似人体内的细胞通过分子通道发送和接收化学信号的交谈环境。细胞通过群体编码相互“交谈”, 2011年美国科学家确定, 一个生物化学信号通道的数据容量不足 1 比特。上世纪 80 年代确定了一些细胞生物关键的信号传导通道, 其中包括核因子 κ B (NF- κ B)。NF- κ B 通道主要调控由细胞做出的各种复杂决定, 对包括压力、自由基、细菌和致命病原体等刺激做出反应。但沿着 NF- κ B 通道行进的化学信使, 携带有多少信息? 到 2007 年研制出了微流路和测量技术, 才测量出了在 NF- κ B 通道上一次出现在数千个细胞上的生物化学信号传输数量, 根据推出的一个公式来分析和定量计算, 实验显示该通道的信号容量不足 1 比特, 只够做出一个二进制决定: 简单的是或非。除了 NF- κ B 以外, 测量其他的生物化学通道的信号, 结果一样。这表明, 数据容量不足 1 比特的生物通道很常见。NF- κ B 生物化学通道其信息容量不足 1 比特, 对比外在的人类社会情形, 说明只类似我们用有线的电流传输的座机电话和用无线的电磁波传输的手机电话通讯, 生命细胞除开在已知的生物化学递质、电流等有形的通信信号传输通道外, 还有多种形式的互相“交谈”, 这就有今天人类才半掌握的多粒子量子纠缠态隐形传输。这里隐形传输也有类似有线的电流传输的座机电话和无线的电磁波传输的手机电话两种通信方式。

4) 与今天的人类生命体相比, 生命起源在原始生命的生物体阶段, 更多存在隐形传输通信方式, 如黏菌的信息素通信, 其中除“有形”的化学信息素外, 还耦合有无线的量子隐形传输。发展到人, 类似有时还可听闻的母子遗传体亲情之间的“心灵感应”、脑电波心灵相通, 就是人类生命体在有了神经系统、视觉、听觉、味觉、触觉系统等信息通道后, 还残留的功能。但仅此还远远不够。实际量子隐形传输是量子相互“交谈”并不需要人为的一种自然、自足、自组环境, 它同超导现象是共存的。这也是高温超导以及有机超导和生物超导起源、统一的基础。所以在化学的原子、分子层次上做隐形传输“交谈”环境的文章并不可取。

因为它们无法通过信号传导通道得到足够的所有信息, 生命量子计算机有时候也许会在细胞这些已知通道外互相“交谈”。DNA 类似双扶手螺旋楼

梯的双螺旋分子结构, 也联系孤子演示链。那类似楼梯的每一梯格框是一种四边形结构, 这跟面旋、线旋运动, 超导现象转座子的最佳网格图案是四边形有联系。在《三旋理论初探》书中有关“有机超导和生物超导”、“生命与量子计算机”和“双螺旋结构与量子计算机”等内容, 为多粒子量子纠缠态隐形传输, 在没有光纤联结和存在噪声干扰的情况下提供了详尽阐述。而即使体温, DNA 双螺旋结构也具有生物超导特定的功能。高温生物超导材料 DNA 晶格中的孤子链不平凡结构, 正是造成这种高温超导宏观量子机制的最重要前提。

2、类似光蚀刻制造印刷电路板的线路, 一维止于多粒子分子、原子。我们已经知道生物隐形传输需要的自然超导环境, 是分子、原子内部量子粒子的一种自然、自足、自组选择操作行为, 这当然比人为光蚀刻制造印刷电路板操作线路方便、省事、高效、先进。以此转到人为制造隐形传输元件芯片, 自然是需要寻找具有自然造就超导能隙的材料, 然而还真有此类发现。

1) 不说远了, 就说 2011 年 9 月斯坦福材料和能源科学研究所的研究生朱丽·伯特和同事与来自日本东京大学的应用物理学家哈罗德·黄一起, 将一薄层铝酸镧放置在一个钛酸锶基座上, 这是把两块不具有磁性的绝缘体粘合在一起, 相遇的接口层居然既有磁性又有超导性, 据此联系, 这是否能启发研制新奇的类似隐形传输芯片需要自然超导环境的材料呢? 隐形传输芯片当然更多需要在常温下工作最好, 而铝酸镧和钛酸锶这两种复合氧化物相遇的原子层, 虽然只是在接近绝对零度的温度下, 电流才毫无电阻地流过该处的, 这表明该原子层具有超导性, 但是铝酸镧和钛酸锶等复合氧化物材料具有磁性的新特性的新材料, 也为研制隐形传输芯片新的计算存储设备磁性和超导性等, 在正常情况下不兼容状态之间的相互作用提供了新的可能性。因为在一般情况下, 超导材料的导电性为 100%, 也会排斥周围的任何磁场。新的探索, 要弄明白这种材料内的磁性和超导性之间是相互对抗还是相互辅助? 用另一种测量方法, 美国麻省理工学院也同时证实, 磁性可存在于两个材料的接口处, 并有望研制出具有可控的、新奇有用的导电性材料新类型。例如试验查看这种材料进行压缩或在其上施加电场时, 磁性和导电性是否会出现变化, 以找出对形成这些氧化物内的磁性和超导性有帮助的物理属性。

2) 还有类似美国加州大学河滨分校发现的一种可在低温下生成电子偶素的新方法, 在获取电子偶素上较为简单也容易操作, 能揭示物质而非反物质生成内部性质方面具有重要价值, 也启发寻找类似隐形传输芯片具有更高临界温度的超导新材料的研制。这是先用激光对硅样本进行照射, 而后在硅表

面浇灌正电子。在激光的照射下，发现硅释放出来的电子与正电子形成了电子偶素。电子偶素是一个电子与一个正电子组成的短周期、类原子结构。由于电子和正电子最终会湮灭产生光子，它的半衰期非常短，电子偶素在介质中的湮灭时间可作为一种非破坏性测量手段。而且能够在非常宽的温度范围内，甚至可以在任何温度下进行，其中还包括非常低的温度，可控式的生产大量电子偶素。包含一个正电子的电子偶素，可以说是最小的原子。

它的研制表明，在正电子到达前用激光照射样品表面，可以帮助正电子离开表面以免发生湮灭，而且电子偶素从样品表面会自然生成。对电子偶素实施冷却，也可产生更多的实验用途的玻色爱因斯坦凝聚态。电子偶素 2003 年确定的半衰期为千万分之一秒多点，组成它的正负电子就同归于尽了。但它的存在时间也要比硅表面的正电子长 200 倍以上，因此很容易探测到。在不同的介质中，电子偶素的半衰期会相应发生变化，因此可以用它来测量物质内部性质。另外由于电子偶素湮灭时可以放出伽马射线，人们也设想用一群电子偶素湮灭来制造高能射线。硅作为生成材料是因为它在电子学中应用极为广泛，可靠、廉价且十分有效。

3) 美国弗吉尼亚联邦大学由于选用特殊材料，开发出一种比传统晶体管要小 4 个数量级能耗最低的集成电路，整个电路所需的能量只有 0.4 阿焦耳，它甚至没有必要为其安装电池，从周围环境获取的微量能量就已足够维持运行，可创造超低功耗、高密度、非易失性的存储器和逻辑芯片。该技术也能启发寻找类似超导量子计算机和隐形传输芯片的研制。例如这种电路使用的是一种被称为多铁性材料的特殊复合材料，由压电材料和磁致伸缩的纳米磁铁结构组成，能够将环境中的机械能或振动转化为运行所需的能量，从而实现从环境取电的功能。在数据存储和传输上，与用接通和断开来表示 0 和 1 的传统电路不同，这种集成电路利用自旋电子学中电子自旋的两种状态来代表二进制中的两个基础代码，整个切换过程中，该设备只需要非常小的能量。

智能的超导材料是一种集材料与结构、智能处理、执行系统、控制系统和传感系统于一体的复杂的材料体系。它的设计与合成几乎横跨所有的高技术学科领域。构成超导智能材料的基本材料组元有压电材料、形状记忆材料、光导纤维、电（磁）流变液、磁致伸缩材料和智能高分子材料等，称智能超导材料结构或智能材料系统。在基体材料中，嵌入具有传感、动作和处理功能的三种原始材料。传感元件采集和检测外界环境给予的信息，控制处理器指挥和激励驱动元件，执行相应的动作。

二、超导隐形能隙传输与弱力能源

能隙指的是在某一段能量区间，电子的态密度

等于 0。通常超导能隙是由于拆开电子对需要一定能量，根据有效能隙方程，超导体中基态和激发态之间存在能量差，即超导能隙由于态的形成，因而在系统中存在两个能隙。但能隙并不是超导性存在的必要条件，赝能隙或许是高温超导物质的另外一个相位，如二硼化镁的超导性有不只一个能带跨越费米面，而且电声耦合所造成的费米面失稳完全可能在两个能带的费米面处产生能隙。即所谓赝能隙现象，是指低能电子激发在高温超导物质中消失，而部分打开的能隙。

1、超导量子信息传输元件的制造，类似将两块不具有磁性的绝缘体如一薄层铝酸镧放置在另一薄层钛酸锶上，相遇的接口层粘合在一起既有磁性又有超导性，这里我们把两个绝缘的薄层看成类似卡西米尔效应的两个平行的平板。而类似三个或三个以上的多层薄膜叠加，是否也可以看成多个卡西米尔效应平板对呢？由于接口层相遇得再紧的平板之间也有空穴，如果比喻为超导能隙；而一个薄膜有两面，它们之间没有空穴，但也可以形成赝能隙。能隙和赝能隙里的真空空穴是如何产生超导现象的呢？

1) 几何纲领和量子纲领之间虽同为实体，但量子起伏的产生和湮灭却颠覆了几何图像原有的变化概念。如量子真空起伏的正负虚粒子对的产生和吸收；同位旋概念的赝电子交换，电子的真空极化或元激发，或能级跃迁，而出现的虚粒子包括虚电子-正电子对介质的产生和湮灭过程、虚发射和再吸收等被称为的鬼场（ghost field）、鬼态（ghost states）的现象。这里，一是可以把产生的众多超导电子库柏对看成类似的等离子体子集体激发，二是可以把电子库柏对从横向耦合，转换成是纵向集体模，再与卡西米尔效应平板联系。这是把长程库仑力包括在内的相互作用，那么能隙和赝能隙存在的超导现象，也含有量子隐形传输的意味。

2) 能隙和赝能隙卡西米尔效应平板之间的量子真空空穴，对映超导或隐形传输的量子传输巡行，能量从哪里来？难道超导性和隐形传输可违反能量守恒定律吗？这里，一是 BCS 理论认为，在超导体中由于电子和晶格振动（声子）的相互作用所提供的吸引力胜过电子之间的库仑排斥作用，从而使具有大小相同、方向相反的能量和自旋的两个电子形成了束缚的电子对。这里即使认为电子对类似一个小环圈及面旋，而像飞去来器模具，声子和库仑排斥作用力都集中在“飞去来器”上能被“散射”，成为在晶格中超导孤波式的流动；但仅用这种“飞去来器”的孤波解释也还是不够的。

3) 因此，二是这种缺失，需要把它们量子卡西米尔效应平板之间的量子真空、空穴，和时空的自然弱力相互作用联系起来，解释超导或隐形传

输存在的自然能源。例如量子鬼场、鬼态的现象，联系原子和原子核层次存在的真空量子介质的性质，类似具有普遍规范耦合的矢量介子，如 π 介子的自然弱力相互作用与电子-正电子对介质的产生和湮灭过程、虚发射和再吸收等现象。

2、如果使用孤子链模具模拟鬼场、鬼态、鬼圈、鬼顶点、鬼自由度等量子性质，还不是量子世界真实面目的忠实描述，那么我们也是为把所有理论实际存在物，当作只是为了经济描述观测到的现象的相似构造，而使用孤子链模具模拟的。

1) 微观 $1/2$ 自旋费米子是标准模型必不可少的，但目前的任何实物模具很难演示，但我们的孤子链确就还能模拟。孤子链起源于三旋理论的扩容：循着由环圈耦合组成链这条思路，要模拟机械孤波滚动，需要以两条单链耦合为基础。这可用大小相同的穿钥匙用的铁圆圈 10 至更多个制作。即让两列链圈依次对应相交，在链条垂直时，段与段圈之间有上下之分，同段同级的两个圈面可以近乎平行重合；而上下不同级段的圈面也可以相互垂直，且上下两圈面垂直的交线与其过圆心的连线可重合。这种情况称为正交。且因一个铁圈的转动为半角度，要平整又顺当，相交是有严格编码要求的。这样把两根圈链耦合起来，挪动“弱轴主流”冠链圈，在垂直的时候，从“弱矢量流”顶链圈开始就会产生机械孤波滚动。我们把具有这种功能的圈链也称为孤子演示链，或孤子链。

2) 孤子链类似编时几何学的仿射联络，具体做法是，两列圈链的耦合编码，由于链圈与链圈上下之间的正交，出现左右、前后两种共轭的编码。以圈子与圈子一对一的套接设为 1，大于或小于一对一的套接设为 0，孤子演示链的编码从上往下的结构是：①弱轴主流领圈 00；②左 10，右 11；③前 01，后 10；④左 01；右 10；⑤前 10，后 01；⑥左 10，右 01；⑦前 01，后 10；⑧左 01，右 10……该共轭编码，只要让第②层的右圈变为弱矢量流领圈，即让原弱轴主流领圈自由落下，就会发生孤波滚动；反之恢复原先的领圈地位，即让后者自由落下，也要发生孤波。

这种滚动不是弱轴主流领圈真正落下，而是圈套之间传递着一种信息、能量和相位，构成类似螺旋状的搅龙轨迹。因此具有类似贝克隆变换的表达式，这是一种类似 SG（正弦--戈登）方程的非线性偏微分方程的描述。这种 SG 方程有正负扭状孤立子解，分别叫正扭和反扭。三旋理论最先把孤子链与 DNA 双螺旋结构相对应，它的左右、前后双共轭编码，对应 DNA 中腺嘌呤 A、鸟嘌呤 G、胞嘧啶 C 和胸腺嘧啶 T 等四种碱基的 T 与 A、C 与 G 必定配对的编码。因此发现孤子链不仅揭示了 DNA 双螺旋结构中存在的孤波现象，而且还揭示了自然界共轭无

处不在。只是人们还没有把共轭与双共轭和多共轭联系起来，没有把双共轭和多共轭与编码联系起来，没有把共轭编码及其强弱与孤波以及四种相互作用和贝克隆变换、SG 方程等深层次现象及现代数学联系起来。

2) 21 世纪高端科技隐形传输掌握的时空量子起伏，实际是延伸为真空涨落的。这就联系到量子力学测不准原理和互补原理。它们说明即使在最深度的真空，也会有粒子的产生和毁灭；而且越是从近处看，那里的粒子越多，但存在的时间就越短，能量就越大。这些粒子经常撞上东西，获取关于它们不期而遇的客体的信息，并把那些信息散播到环境中。所以，自然界总是在利用这些粒子进行测量，阻止自然界这样做是不可能的。即使在真空中，即使屏蔽了一切外部影响，处于未衰变/已衰变状态的叠加状态中的一个原子核，也会随时受到自然界的这类测量。这些粒子随即再次消失在真空中，这也叫真空涨落或量子起伏。但如果有证明量子起伏或真空涨落最基础的实验，或有可观感捉摸的演示工具，那么这个从宏观到微观都可观感捉摸的实验是什么？它的最基础的数学原理又是什么？这就是著名的卡西米尔效应的平板实验和超导孤子演示链。

3) 超导体是一个可捉摸的“上帝”，神奇到“反能量守恒”定律科学常识。因为它是一种实空间材料，却具有零电阻，反磁性，和量子隧道效应的奇特的性质。这与量子真空具有奇特超导体性质差不多。演示粒子之间的这些相互作用，孤子链类似拉格朗日函数的粒子的集体坐标表示式，又类似矩阵；三旋环圈则类似矩阵元。而三旋是纯动量坐标的模拟，类似哈密顿量函数。把三旋动量旋球看成彭罗斯扭量球，孤子链就类似扭量球的傅里叶展开式。实际三旋和孤子链也类似量子力学中的算符，具体模拟可针对不同对象有不同的表现形式。例如，用正弦-戈登方程描述类似拓扑性的扭结孤子和反扭结孤子传播的孤子演示链，它的每个圈子体旋是为 $1/2$ 的自旋，可对应粒子系统的费米子和反费米子，其玻色子可采用一个费米子-反费米子对划段的形式出现。

4) 卡西米尔平板效应的这种超导体性质，也类似量子隧道隐形传输效应，两者都可以用费曼图表示的量子电动力学的光子对电荷响应的三个基本图示来说明，特别是该图示中的“全虚拟过程”图示：在两个电子之间交换虚光子，或在一个电子圈图之间交换虚光子，在虚光子的力线中间又可以产生电子圈图。这种虚光子的力线可以间开有多条，而虚光子的一条力线中间产生的电子圈图也可以间开有多个，这类似有孤子演示链的一些元素。但如何把它们完整地联系起来，量子色动几何的立方体和超立方体，能对应高温超导体中的氧元素：从卡

西米尔效应的平板联系真空的量子起伏、量子涨落，推导氧元素外源性量子色动力学效应，我们早有结果。平面几何和立体几何告诉我们，3个点可形成一个平面，8点可形成一个立方体。两个正三角形可形成一个6点五面体。立方体的平板卡西米尔效应比6点五面体的大。把这类“点”换成质子数，立方体变成了氧元素，六面体变成了碳元素。16个点可形成一个超立方体。

在化学元素原子中，与质子质量相近的还有中子，为什么单独把质子数，作为认定的标准呢？道理，一是，抓主要矛盾。二是质子类似领军人物。但正因是领军人物，性质就不同了。以8点的立方体和6点五面体为基础，在它们的卡西米尔效应平板的一个面上加一个点，如此堆垒扩张作各种几何体图形，并联系对应点的质子数的原子元素化学性质，作量子色动力学分析，称为量子色动几何。

5) 量子色动几何的氧标本，是卡西米尔效应的核心。从上面可以看出，6个质子的碳原子核的理想量子色动几何图案，是两个三角形连接形成的含平行的五面立体图像；我们称为碳基量子色动几何图像。而8个质子的氧原子核的理想量子色动几何图案，是两个正方形连接形成的上下、左右、前后平行的正立方体图像；我们称为氧基量子色动几何图像。由此来说量子色动化学，碳基量子色动几何图像比氧基量子色动几何图像虽然“经济”，但没有上下、左右、前后对称的3对卡西米尔平板效应作用力大。但就是这个量子相互作用力，是最基本的实验可证实的力，地壳元素中分布最多的前9个元素，氧才占据了首位。这也是几十亿年以来，地壳发生的无数次大地震和火山爆发等中的这种力量的化学微调，氧才占据了首位的。

即这个最简约的数“8”，类似正方形的8个顶点，在局域和全局也是最接近、最简约的是一对或上下、左右、前后三对卡西米尔效应平板的经验图像和先验图像。它对于所有的自然数，甚至包括所有的实数、复数来说，后者虽然是无限的多，但“8”却只有一个，这使8的概率，在自然界只是无限分之一，即类似没有奇迹能发生。但为什么在高温超导体材料中奇迹却发生了呢？这就是从量子色动力学与量子色动几何来探索高温超导体的外源性量子色动化学，就类似于风筝飞上天，不同于飞机飞上天、火箭飞上天、氢气球飞上天、孔明灯飞上天、鸟飞上天等类型，是利用外在自带的量子色荷云能的起伏效应。

6) 费曼图表示的量子电动力学的光子对电荷响应，实际两个分开的电子或在一个电子圈图，在适当的条件下也可以看成一对卡西米尔力效应平板。一个电子对实际类似一个圈态，且圈态联系自旋的三旋设计。而电子对也称库柏对，是超导理论解释

超导起因的基本概念。把这种圈图联系孤子演示链和自旋电子学。自旋超导体的电路设计，自旋电子学类似在指明缩小做电路的体积。其次，自旋电路也类似一系列相互联系的逻辑门，每个逻辑门在一层超导体层上拥有磁接触，电子自旋决定了这些接触的磁状态，它们相应于孤子演示链信息传递中的0和1。通过在其中的磁接触和超导体之间移动电子实现是可行的。

孤子演示链，圈子虚拟，可以对应卡西米尔力平板真空之间虚光子对电荷响应的无障碍；而孤子演示链，圈子的实在和圈子的堆垒编码的孤子传播无障碍，也可以对应超导、超流的无障碍。把氧基量子色动几何图像，把碳基量子色动几何图像，映射孤子演示链，映射高温超导体。单以氧基来说，它类似孤子演示链中的一条可提动的链条，每个氧原子中的质子色动几何图又类似其中的一个圈。这里，包括常规超导体的微观理论库柏对型配圈图，也在其中。而铜氧系高温超导体，到铜氧系体中的自旋波，一维铜氧系体链中的孤波；铁氧系高温超导体，到铁氧系体中的自旋波，一维铁氧系体链中的孤波，中心有氧，也类似孤子演示链中的一条可提动的链条。抓住这条主要矛盾，至于别的型配材料链，就是次要矛盾了。孤子演示链大统一常规超导体的微观理论库柏对，高温超导铜氧系、铁氧系等的微观理论，孤子演示链实际可虚拟为超导演示链、时空演示链、量子隧道隐形传输效应……。

3、用弱力能源解释超导或隐形传输的量子传输巡行，水槽模型式的孤波和孤子链模型式的孤波互为补充，但各有区别的。水槽产生的孤波虽然可以表征粒子，但和孤子演示链的单独一个圈子比起来，水槽孤波和水槽其余的水最终没有彻底切割。再说孤子的钟形弦态，与圈子的奇点孔态，在拓扑类型是不统一的。在这一点上，各类高温超导材料的机理与BCS理论并不完全一致，所以高温超导的一些定量数学描述并不如BCS在低温超导那么成功。其次，量脑和超导隐形传输设备研制，即使寻找到原子薄层相遇的接口层在常温下获得兼容既有磁性又有超导性的，类似铝酸镧和钛酸锶两种复合氧化物的新特性的新材料，但隐形传输计算存储设备，除开外界认为输入的能源外，为什么类似孤子链的能量和信息传输巡行需要的能源，对映其中的高温超导的能隙可以那么小，甚至可以忽略不计？对映隐形传输的量子传输巡行，能量从哪里来？难道超导性和隐形传输可违反能量守恒定律吗？

1) 其实超导性和隐形传输本身就是一种量子发动机。例如1914年昂尼斯将铅丝做成闭合圆环，让磁场的方向垂直于环的圆平面，然后浸在液氮中降温进入超导态后去掉外磁场，闭合超导线圈内感生的电流持久循环，就一个经典的量子发动机模型。

而超导说白了，单纯的磁场本质是什么？我们说它是暗物质其中的一种类型之一。

昂尼斯的铅丝闭合圆环浸在液氦中降温进入超导态后，去掉外磁场，圈内感生的循环流动不止的电流，又会沿着圆环自发感生出一组穿流内圈循环流动不止的磁力线，其中每一根单独的磁力线也是闭合成圆环的量子，取其中单独的一根磁力线量子，我们叫做磁单极量子，以整个铅丝闭合圆环感生磁场 N 和 S 极取向，磁单极量子的自旋可分为 N 子和 S 子两种。其次，对应电磁波传播，把变化的电场产出变化的磁场，变化的磁场又产出变化的磁场，看成双环编织态，电环变化的电场称 D 环；磁环变化的磁场称 C 环。在类似超导、量子隐形传输的双环 D 环与 C 环互感、翻转共生的电磁波传播理论中，由于引进磁单极量子的存在，类似电子对粒子的四周，会存在无数条飞舞的更微观的单链。这类单链还可选择编码，有组成双链式的孤子链的概率。

由此类似超导、量子隐形传输的真空量子起伏，产生和湮灭类似的真空鬼场、鬼态、鬼圈、鬼顶点、鬼自由度等，就能得到孤子链模具的演示。由于磁单极量子涉及暗物质，即使捕捉不到它们，但实验也能测量到它们的物理、化学、生物等效应。所以类似麦克斯韦的电磁场量子电磁波传播的磁环 C 与电环 D 圈套圈耦合，再代换为李群数学的以面旋和线旋耦合描述，称为类似 $U(1)$ 局部对称性群的孤子链式的能量与信息耦合巡回运动。但孤子链不仅能演示 $U(1)$ 局部对称性群，还能演示 $SU(2)$ 、 $SU(3)$ 局部对称性群和 $U(1)$ $SU(2)$ 、 $SU(3)$ 之间的组合选择。

微观粒子大多数都带有电荷，其电子在介子真空极化也能产生非放射性衰变式的弱力量子发动机类似的孤子链的能量与信息耦合巡回组装。具体说到超导量子发动机，经典解释说是电子与晶格振动相互作用而产生的：在超导态金属中电子以晶格波为媒介相互吸引而形成电子对，无数电子对相互重叠又常常互换搭配对象形成一个类似的孤子链孤波的整体流动。由此再联系有效能隙、赝能隙和超导体中基态和激发态，实验证实类似用高能紫外线照射二硼化镁晶体，将超导电子对从中分离出来用“角度分解光电子分光”的方法观察它的能量状态，发现有硼原子层中 σ 电子做二维运动， π 电子则按垂直于这个面的方向运动。 σ 电子的能隙比 π 电子大 3—4 倍。

2) 传递引力相互作用的媒介子为引力子，传递电磁相互作用的是光子，传递弱相互作用的是中间玻色子，传递强相互作用的是胶子。胶子只在夸克之间交换，不在核子间交换； π 介子量子色荷云只在核子间交换，而不在夸克间交换；量子色动力学

真空充满了不断出现而又迅速消逝的虚夸克-反夸克对鬼态。弱力量子发动机类似孤子链的孤波能源，正是真空屏蔽极化现象能隙和赝能隙跳跃过程的 π 介子。原子核内存在 π 介子的集体模式，一个上夸克和一个反下夸克构成一个 π^+ ，一个下夸克和一个反上夸克构成一个 π^- ，它们互为反粒子。中性的组合是上夸克和反上夸克、下夸克和反下夸克组成 π^0 。 π^0 的反粒子就是自己。 π^+ 介子因弱作用而衰变： $\pi^+ \rightarrow \mu^+ + \nu_\mu$ ； $\pi^- \rightarrow \mu^- + \nu_\mu$ 。 $\pi^+ \rightarrow e^+ + \nu_e$ ； $\pi^- \rightarrow e^- + \nu_e$ 。放射性轻子型衰变，即 β 衰变，最终生成一个中性 π 介子，情况少。而由电磁力作用的衰变，是主要形式： $\pi^0 \rightarrow 2\gamma$ 占 98.798%； $\pi^0 \rightarrow \gamma + e^- + e^+$ 占 1.198%。

3) 孤子链能模拟鬼场、鬼态、鬼圈、鬼顶点、鬼自由度等量子性质说明环面是奇点有两种智慧。一种是把奇点看成是不可穿透的球，是一种智慧。而把奇点扩容到环面，是另一种智慧。1/2 自旋即使是一种不带电的基本粒子，但它仍是费米子，不是玻色子。群论类似一种分数自旋。环量子整体对称性向局部对称性的孤子链过渡，能用群论自旋语言描绘四种相互作用力。如环量子线旋电磁力起源于 $U(1)$ 局部对称性，弱力起源于 $SU(2)$ 局部对称性，而强力起源于 $SU(3)$ 局部对称性。 $U(1)$ 是阿贝尔群， $SU(2)$ 和 $SU(3)$ 都属于非阿贝尔群。量子力学传统的自旋理解，是直接薛定谔方程套用洛仑兹变换四维矢量的克莱因—戈登方程，后电子波函数演化方程的狄拉克方程，电子的 1/2 自旋成为必然的相对论要求。但狄拉克方程冲击“负能解”，即对于自旋为半整数倍的费米子，由于泡利不相容原理存在，负能量海的解释虽说得过去，但对自旋为整数倍的玻色子，负能量海意味着所有的玻色子都要无限制地跌入负能级之中。于是费曼提出了一个类似“点内空间”的赝能隙观点：反粒子是“时间向后走的粒子”，或者是逆着粒子的时间运动的粒子。从时间流逝的方向来看，这个粒子与来自 (x_0, t_0) 的粒子接触并双双消失，留下能量为 $2m c^2$ 的光子；这个过程正是正反粒子对产生与湮灭的过程。

这种能隙因素用世界线来描述该粒子运动的话，把正电子当成是进入“点内空间”，也就是当成逆着时间方向运动的电子，它从运动 t_1 到那 t_2 段位于光锥之外，是“类空”（点内空间）的能隙路径。在这个极限的两侧点外空间和点内空间，分别存在着时间流逝方向相反的粒子。也就是说沿着时间方向看时 t_2 刻一个电子正在运动，在远处位 x_2 置突然出现了一对正负电子对；之后就是原来时 t_1 刻的电子与新产生的正电子湮灭，而新产生的那个电子则继续朝向 (x_3, t_3) 运动，这样的话新产生的电子可以看做原电子的未来。如果把“点内空间”当成是能隙因素，把这整个过程当成一个电子被能隙两次散射的话，这看起来就是该电子在能隙“点内空间”

时 t_2 刻完成了一个超时空的跳跃，然后时 t_1 刻本体才消亡。

三、超导隐形传输与实验设计

量子超导隐形传输实现的难点真正在哪里？郭光灿院士是我国量子隐形传输的权威之一，他和高山著述的《爱因斯坦的幽灵——量子纠缠之谜》一书和我们推导总结的隐秩序、量子计算机与双螺旋结构的三旋联系、超导量子信息技术等论著，可以作为超导量子隐形传输实现认知的基础。

1、纠缠不等于共轭，共轭不等于缠结，缠结不等于幽灵，幽灵不等于超光速，超光速不等于实数超光速，实数超光速不等于虚数超光速。量子隐形传输态到底能够应用到什么程度？这里的问题是，《爱因斯坦的幽灵——量子纠缠之谜》一书（以下简称《郭书》）的量子隐形传态原理图中，有发送者、EPR源和接收者三者之间类似成等腰三角形，EPR源在等腰三角形的顶点，到发送者和接收者的距离类似相等。而EPR源实际是靠近发送者一边，才好把发送者的“明文”和加密的“密钥”及时处理在一起，以便才有量子通信的实用效果。这里发送者和接收者之间实际存在有三种关系连接线：a、从EPR源分别到发送者和接收者的关系连线；b、发送者把未知量子态加进自己一方的EPR源缠结量子后，此信息隐形传输给接收者的关系连线；c、发送者测量未知量子态与自己一方的EPR源缠结量子后，用经典通信告诉接收者的关系连线。

由此，《郭书》的上述三种关系连接线都画为实线，没有无错。但分析《郭书》在上述三种关系连接线，是变为只有两条：(a)从EPR源分别到发送者和接收者的关系连线；(c)发送者测量未知量子态与自己一方的EPR源缠结量子后，用经典通信告诉接收者的关系连线。这是类似把(b)发送者在未知量子态加进自己一方的EPR源缠结量子后，将此信息隐形传输给接收者的关系连线，与(c)线合一；这也没有无错。在其次，《郭书》把上述三种关系连接线变为只有一条，也是可行的；而且郭光灿在北京和芜湖的实际运用中，也许正是只用一条线路，也达到了目的。

然而把彭罗斯的《通往实在之路》一书（以下简称《彭书》）与《郭书》相比，彭罗斯更着重于量子纠缠的原理阐述。以《彭书》中显示量子纠缠的非因果性传播的“量子隐形传输”图来说，EPR源也类似在等腰三角形的顶点，到发送者和接收者的距离类似相等；从EPR源分别到发送者和接收者的关系连线，彭罗斯也画了实的线路，但实际是虚的线路。原因是从EPR源被分成纠缠对的两个量子态，分别到发送者和接收者手里后，可以各自保存很多年时间，只要不与别的量子态接触，它们仍然是原样成纠缠对的两个量子态。其次，发送者和接收者

的分离和各自带走，可以不用线路连接，而是可以用交通工具，如飞机、飞船、火车、轮船等。即这类似一条折叠的已经消失的关系连线。再其次，类似b，发送者把未知量子态加进自己一方的EPR源缠结量子后，此信息隐形传输给接收者的关系连线，在发送者的操作时间发生后，是没有的。如果这条关系连线还存在，只能是在发送者的操作时间发生之前，即那条从EPR源被分成纠缠对的两个量子态，分别到发送者和接收者手里后，发送者和接收者用交通工具，如飞机、飞船、火车、轮船等，各自带走的线路连接，因此，这只能是一条过去时线路。正是从这里，彭罗斯启迪我们把哈尔彭的《伟大的超越》一书中说的，像毛毯一样折叠的连续的多层膜世界和额外维理论，与此联系起来。

1)由此，彭罗斯也才能把EPR源不是放在到发送者和接收者的距离类似相等的地方，更不是放在靠近发送者一边，而是放在靠近接收者一边。这由此才能谈论郭光灿念念不忘的“时间分割”和“实数超光速”问题。因为如果EPR源放在靠近接收者一边，那么从EPR源被分成纠缠对的两个量子态，分别到发送者和接收者手里后的时间，接收者就在发送者之前。所以，发送者能把未知量子态与自己一方的EPR源缠结量子的合并操作，只能在接收者接收到自己一方的EPR源缠结量子的时间之后。这两者静止同时性的非纠缠性时间差，正是谈论“时间分割”和“实数超光速”问题的基础。但是对于沿接收者到发送者方向高速行进的观察者来说，彭罗斯认为，则应是发送者测量未知量子态与自己一方的EPR源缠结量子合并的时间，是发生在接收者接收到自己一方的EPR源缠结量子的时间之先。

2)其原因是，彭罗斯首创了量子发散态(U)过程和收缩态(R)过程的自主知识产权理论。U过程对应韦尔张量，R过程对应里奇张量，于是彭罗斯用韦尔张量和里奇张量清楚地简化了爱因斯坦的广义相对论引力方程，也能清楚地说明量子退相干和量子宇宙学的一些难题。所以彭罗斯是用三组平行线与一条斜线相交来说明的。斜线代表沿接收者到发送者方向高速行进的观察者。而观察者高速的出发时间，在EPR源操作之后，又在接收者和发送者分别接收到自己一方的EPR源缠结量子之前，但这之间的时空已不是静止性和非纠缠性的。我们假设接收者和发送者分开的方向是一组平行线，如果EPR源发散态(U)操作，那么在接收者和发送者分别接收到自己一方的EPR源缠结量子后的收缩态(R)操作，从两者静止同时性的非纠缠性看，只能是一组垂直于接收者和发送者方向的另一组平行线。而从观察者高速行进的不是静止性和非纠缠性看来，在接收者和发送者分别接收到自己一方的EPR源缠结量子后的收缩态(R)操作，产生的纠

缠性量子幽灵的这组平行线，是向观察者高速出发时的方向倾斜。因此按观察者的“倾斜的”同时性直线来看，自然是发送者的测量发散 U 操作点，和使得位于接收者的 R 态收缩同时点，这两点的连线与观察者高速行进的斜线的相交点，是先发生于：接收者接收到自己一方的 EPR 源缠结量子后发散收缩了的非缠结 U 操作点，和使得位于发送者的 R 态收缩同时点，这两点的连线与观察者高速行进的斜线的相交点的。

3) 彭罗斯虽然没有用超光速直接解释纠缠性量子幽灵，但其实他是把超光速隐藏在量子发散态 (U) 过程和收缩态 (R) 过程的纠缠性解释中的。这代表的是 1935 年爱因斯坦的原始 EPR 效应图像。实际是用虚数超光速直接解释的纠缠性量子幽灵的。因为彭罗斯把发送者的测量发散 U 操作点，和使得位于接收者的 R 态收缩同时点的这两点的连线，是用过去时联系的非因果量子纠缠态点画线标注的，这实际就是一种虚数超光速解释。这条过去时联系的非因果量子纠缠态连线，实际在哪里？我们说，就在“点内空间”，它变成了点内空间类似毛毯一样折叠的连续的多层膜路或者一种额外维。

20 世纪 90 年代后量子信息学应用型研究，超光速仍是解释纠缠性量子幽灵避不开的话题。郭光灿虽没有类似量子发散态 U 和收缩态 R 的自主知识产权理论的遮挡，也没有我们的虚数超光速解释是用点内空间、赛博空间一类的毛毯一样折叠的膜理论、额外维理论的解释。所以剩下给他的，只能是实数超光速解释。虽然在《郭书》说了从量子密码到完全保密的量子通信，从量子计算机到未来的量子互联网，量子纠缠都将大显身手，有大用处，但在《彭书》上仍然说，不清楚量子纠缠思想能够应用到什么程度。

4) 三旋模型对于爱因斯坦、波多尔斯基、罗森发现的量子 EPR 效应的理解是，众所周知，指南针在地球各地除两极外，都能定向相同指向南方。这个道理很简单，是因为地球磁场对指南针的作用引起的。因此也说明如航天飞机或人造卫星离开地球，或在受磁性材料干扰的地方，用指南针定向是不适用的。但科学家们找到了一种陀螺罗盘，不需靠磁力线的作用来定向，而是利用陀螺本身的多层自旋来定向的。这种自旋定向的原理，揭示了自然界中自旋调制耦合功能的 EPR 效应普遍存在。然而在宏观物体身上是很难做到。非粒子量子圈态线旋客体，因为三旋是它的自然属性。因此是一种天然的超级陀螺罗盘。在 EPR 实验中之所以曾经耦合过的光子，在分开以后还会出现整体效应，这正是因为像陀螺罗盘在出发之前经调制一样，耦合过的光子，它们像经过调制的陀螺一样，离开地面的陀螺罗盘的方位测量，是跟它调制配对时的陀螺罗盘的

方向测量一致的，因此在 EPR 测量中，两者的量子效应是一样的。

类圈体三旋虽能解决 1935 年的量子幽灵 EPR 现象的难题，但要全部解答郭光灿院士书中描述的幽灵般超距缠结和退相干问题，是不可能的。好在量子类圈体三旋的科学假说，是量子幽灵 EPR 现象有无虚或实超光速，都是不能或缺的。其次才是类圈体三旋的自主理论产生后，我们近 50 年的发展，三旋弦膜圈说已是建立在现有膜圈说的随意与持续组合上。例如，类似现有的发光壁纸技术与苯分子晶体管技术，和现有的 EPR 量子纠缠整体效应、退相干效应科学假说与三旋弦膜圈假说以全新方式组合，能否通向量子色动化学的未来低碳能源等市场化的一类应用呢？其实道理是相通的。以郭光灿书的量子隐形传态原理图为例作变换， EPR 源就是生产发光壁纸，其核心技术包括了类似苯分子晶体管技术的运用。其效果是这种发光壁纸必须达到能配对产生量子纠缠整体效应。接收者是买方，类似用户。发送者是卖方，这类似电力公司或电信公司的机制模式，也许还包括特殊发电厂。这种发光材料是制成薄膜的能覆盖在墙壁上的发光壁纸；当然这种材料的显示能效，比现在的标准节能灯和发电厂要更方便和更省电、更廉价。这里 EPR 源实际是靠近发送者一边，但用户发送需求的“明文”和加密的“密钥”处理，又好像在接收者这边；而且也需要用经典通信连线用户和卖方。

真实的发光壁纸是，这一新产品使用非常薄的有机材料涂层和玻璃基板，当有电流通过时，这些有机材料就会发光。现有的产品在大面积显示、降低成本和延长使用寿命等方面都有待改进。真实的苯分子晶体管技术是，制作分子晶体管的材料是单个苯分子，苯分子在附着到黄金触点上后，就可以发挥硅晶体管一样的作用，能够利用通过触点施加在苯分子上的电压，操纵苯分子的不同能态，进而控制流经该分子的电流。其原理类似像推一个球滚过山顶，球就代表电流，而山的高度则代表苯分子的不同能态。调整山的高度，山低时允许电流通过，而山高时则阻止电流通过。由于流经苯分子的电流能够控制，因此就可以像使用普通晶体管一样使用苯分子晶体管。但这两者的实际应用，也许还需要几年或者几十年的时间。量子隐形传态发光壁纸和真实的发光壁纸与真实的苯分子晶体管还是两码事，但拿这些现有的技术为基础，以量子隐形传输全新方式组合的结果，是可能开发得出来的。

2、量子纠缠是两个(或多个)粒子的叠加态，这些粒子作为一个整体来看如果试图窃听或偷走其中一个光子的信息，你将任何信息都得不到。因为量子纠缠类似指两个粒子的自旋态类型完全相同，这类自然光，经过偏振片后改变成为具有一定振

动方向的光；或自旋态完全是正交与对称的，而不是完全的硬性连接。其次，所谓的“超光速”，对应平均速度和瞬时速度，也有平均超光速和瞬时超光速的分别。平均超光速偏重计算得出的结果，瞬时超光速偏重直接测量得出的结果。如翻山越岭过高山后的汽车平均速度和穿过这座高山的隧道口的瞬时速度可以相同，但计算穿过这座高山隧道后的汽车平均速度，就可能大于翻山越岭过高山的平均速度。类此超光速有“速度”和“点内空间”之说，相对有形的物质是一种类似虚数的暗物质。

我们把《郭书》对隐形传输提出“波函数坍缩过程的规律很可能违背相对性原理，从而导致绝对参照系的存在”，而进行的二次量子化处理解决相对论的局域性与量子力学的全域性不协调问题，称为郭光灿超光速辐射，或简称“超光速辐射”。《郭书》“探寻绝对说”的“最小本体论”，指某种事物从根本上不可测知，它便是不存在的，可以证伪相对论和量子力学。《郭书》说佩西瓦的“双贝尔实验”，最能使爱因斯坦相对性原理失效。但用超光速辐射，却能证明“双贝尔实验”并不完善：连续运动空间如齿轮传动，速度是有限的，类似不能超光速。非连续运动必然有间断，在不同性质的间断还能连续运动，称为超距作用。而超距作用本质上是具有瞬时性和非连续性，它无法利用空间传播过程来描述。数学上的无穷大速度等价于瞬时性，即实超光速类似等价于超距作用。

贝尔定理对超距作用的理解为非定域性，所以量子理论的非连续、间断性，也可理解为允许非定域性或超距作用的存在。波函数坍缩类似间断、非连续，非定域性，无法利用“空间”传播过程来描述，那么这个“空间”在数学上指什么样的“空间”？其实这才是爱因斯坦和玻尔之间的分歧。相对论说数学方程中的虚数应该去掉，而玻尔却把爱因斯坦丢掉的数学拾起来，认为这个“空间”类似希尔伯特空间，是虚数和实数兼容的复数时空，即类似“点内空间”——这可比作房子；空间的点类似房子，“点内空间”和“点外空间”构成的虚数和实数兼容的复数时空机械“连续”图像。

那么爱因斯坦和玻尔谁对谁错呢？贝尔不等式的无数实验证明，玻尔更具有辩证特色。但爱因斯坦和玻尔两人在数学上都留下洛仑兹不变性式的虚数，即洛仑兹不变性数学结构是虚数和实数兼容存在的。所以所谓的量子非定域现象不满足洛仑兹不变性，是人为造成的。简单总结一下，如果把连续性的“点外空间”正、反称为一次量子化，非连续性的“点内空间”正、反称为二次量子化，那么即是：连续性相对论一次量子化——非连续——非定域性——波函数坍缩——二次量子化——郭光灿超光速辐射——霍金辐射——相对论二次量子化。双贝尔实验的因

果回路，正是相对论的二次量子化要说明的。

即联系霍金黑洞辐射，黑洞外部附近的量子真空起伏，是指造成的一个粒子及其反粒子构成的成对粒子，在彼此湮灭并最终双双消失前，如果可以在非常短暂时间内在真空区自然出现，这是一种连续性的“点外空间”负实数或者虚数的一次相对论量子化。如果这种成对粒子在黑洞边缘附近形成，其中的粒子在被摧毁前可能掉入黑洞，反粒子则被搁浅在事件视界之外——这种一次相对论量子化的“量子纠缠”，被称为是黑洞存在“霍金辐射”。那么郭光灿超光速辐射相对论二次量子化是，光子被感光屏上处于此区域的原子吸收了，被看成类似量子落入“霍金黑洞”，那么它是分成两个过程演化的。一是，量子波粒二象性检测，粒子打在检测屏上产生的决定性结果，常常被称为退相干效应。如果我们把从量子叠加到检测屏上退相干的决定性结果的湮灭粒子，进一步导致大量临近原子的一种不可逆过程，看成类似黑洞边缘附近形成的量子真空起伏，造成由一个粒子及其反粒子构成的成对粒子，在最终产生感光屏上的一个永久记录前其中的粒子可能掉入“点内空间”，它的反粒子则被搁浅在“点外空间”，由于它也是虚数粒子，所以这个“点外空间”相对它来说，也是“点内空间”。但这实际是相对论二次量子化，这里由于留下的正虚数粒子受到真正“点内空间”另一侧正虚数粒子的排斥，而发生类似退相干“霍金辐射”的郭光灿超光速辐射，这就是 EPR 量子幽灵发生量子移物隐形传输的图像。

其次，因为这种量子波粒二象性实验检测，已经是一个实际的操作过程，那么退相干湮灭的实际的粒子，对整个实际的实验粒子和“点外空间”来说，这也类似“点外空间”狄拉克量子海洋，落入检测屏中的湮灭粒子走了，自然在狄拉克“点外空间”量子海洋一侧膜面搁浅留下一个“空洞”。如果设落入检测屏中的湮灭粒子为负虚数粒子，那么在狄拉克“点外空间”量子海洋一侧膜面留下的那一个“空洞”也类似一个实数，被分为正、负两个实数粒子。“空洞”这个负实数粒子的突然收缩消失，会进一步导致大量临近量子的一种不可逆的动力过程，造成相对论时空允许的类似顺时针和反时针相间连续传动的齿轮传动图像。这是超光速辐射补充的相对论一次量子化图像。正是有以上两种“齿轮传动”，双贝尔实验不能说明它想要说明的问题。即双贝尔实验涉及的爱因斯坦幽灵，属于“宇宙极问”难题。

1) 所谓的“双贝尔实验”，类似 A 和 B 俩亲兄弟与 C 和 D 俩亲姊妹，4 人都各自分开在不同地方工作，除开 B 与 C 因恋爱有电话联系、D 与 A 因恋爱有电话联系外，他们两个无关的不同家庭或家族的成员，但他们都有相同的社会背景或受到生存

迫害。A 先操作，B 通过家族可以听到消息。相应地，C 先操作，D 通过家族可以听到消息。按连续定域性常规逻辑的消息回路时序：假设 A 先自杀，通过家族传言 B 听到消息，B 通过电话告诉 C。于是 C 先自杀，通过家族传言 D 听到消息，D 通过电话告诉 A。但在常规逻辑中也有这种情况，由于事件 A 和 B 之间、C 和 D 之间，仅仅是传言以及没有恋爱关系，上面的回路时序，可以存在不会形成逻辑上被禁止的因果回路。

如果把把这个事件引进到类似超光速辐射的量子纠缠系统中，这两种对应的情况也存在，按量子纠缠系统可释为“预感”。相对论一次量子化，对应按连续定域性常规逻辑的消息回路时序，那么郭光灿超光速辐射的相对论二次量子化类似，假设 A 先自杀；通过家族传言，B 还没有听到消息也自杀了，原因是 B 对 A 的自杀早有预感，而悲观。但 B 在自杀之前，B 通过电话告诉了 C。于是 C 悲观先自杀，但通过家族传言，D 还没有听到消息也自杀了，原因也是 C 对 D 的自杀也早有预感，而悲观。当然，D 在自杀之前，D 通过电话告诉了 A。那么 A、B 之间及 C、D 之间，存在的这种类似的量子因果“预感”连接，使上述的时序回路形成因果回路，也是有可能的。

2)但这里也出现悖论：一是 B 与 C 的电话联系，D 与 A 的电话联系，谁先？谁后？如果 B 对 A 的预感先于传言，其时间差用来填补 B 与 C 的电话联系多用出的时间；D 对 C 的预感先于传言，其时间差用来填补 D 与 A 的电话联系多用出的时间，B 与 C 的电话联系和 D 与 A 的电话联系，两者可以是同时的，那么即使有因果回路，也是等价于零的。其次，也说明，在宇宙极问条件下，相对论与量子理论即使有悖论，在实践意义上也是等价的。证明是，A 先自杀，通过家族传言 B 听到消息，不等价于 B 用电话与 A 联系的验证。D 先自杀，通过家族传言 C 听到消息，不等价于 D 用电话与 C 联系的验证。所以不管是有连续定域性常规传言逻辑回路，还是没有非连续非定域性超光速预感逻辑回路，可靠性仍需爱因斯坦类似机械特点的用电话联系验证。

3) 目前有争论：多粒子量子纠缠态隐形传输，是否真的按确定数目的是光子进行的光子量子态隐形传输？从物理角度讲，用不着在普朗克长度单位的范围进行单个光子的一一测量。因为比特是个两态系统，它可以制备为两个可识别状态中的一个，如是或非，真或假，0 或 1。在数字计算机中，电容器平板之间的电压可表示信息比特，有电荷代表 1，无电荷代表 0。一个比特的信息，还可以用两个不同的光偏振或原子的两个不同能级来编码。量子信息的单元称为量子比特，它是两个逻辑态的叠加态。经典比特可以看成量子比特的特例。用量子态来表

示信息是量子信息的出发点，有关信息的所有问题都必须采用量子力学理论来处理，信息的演变遵从薛定谔方程，信息传输就是量子态在量子通道中的传送，信息提取便是对量子系统实行量子测量。在实验中任何两态的量子系统都可以用来制备成量子比特，常见的有：光子的正交偏振态、电子或原子核的自旋、原子或量子点的能级、任何量子系统的空间模式等。而光子是玻色子，可以有多于两个粒子的组合。信息一旦量子化，量子力学的特性便成为量子信息的物理基础。

4) 量子态是指原子、中子、质子等粒子的状态。如果把表征量子态的能量、旋转、运动、磁场等物理特性看作量子信息，那么这些量子信息还包含了其物理特性的共轭态，所以粒子的量子信息常常是多共轭的。这在基本粒子物理学中大部分是用标准模型和超对称理论处理的。由于以爱因斯坦为代表的一方始终认定量子力学不是完备的理论，而以哥本哈根学派领袖玻尔为代表的另一方则坚信量子理论的正确性，使宏观和微观之间的认知的矛盾尖锐起来。

一是量子力学在继承宏观物体的球量子模型时，又抛弃了球量子的自旋概念，另立一套与宏观不同的自旋概念。这是由于量子客体的波粒两象性，迫使人们不得不引入波函数（量子态）来描述量子客体的状态，量子世界的千奇百怪的特性正是起源于这个量子态。那么这个量子客体的状态，按宏观的特性是个什么概念呢？这是一个既似刚体又像流体、既似完整又像破裂的“模糊体”的不确定性概念。

自旋不像平动。平动类似趋向弥漫或弥散态，自旋更像一种浓缩的“体”。环量子三旋模型不是对正统量子力学本身作出变革，而是仅就正统量子论本身作出一点变革。即既然坂田昌一反对量子力学哥本哈根学派不可分思想的“点”模型，主张能够分的“体”模型，那么量子态的“体”也可以有类似宏观物体的自旋，这使我国过早地引发了球量子与环量子之争。因为环量子与球量子的内禀自旋是不同的。例如环量子的自旋有三种“内禀”运动：可以有体旋——绕圈面内轴线的旋转；面旋——绕垂直于圈面中心的轴线旋转；线旋——绕圈体内环状中心线的旋转。

三旋的体旋有二种状态(正、反)。面旋有二种状态(正、反)。线旋中的平凡线旋有二种状态(正、反)；线旋中的非平凡线旋有四种状态(左斜正、反；右斜正、反)。环量子按单动(只做一种旋动)、双动(同时做两种旋动)、三动(同时做三种旋动)，可以有 62 种不同的三旋状态组合。而其中的线旋就类似宏观的涡旋，所以环量子能完成既似刚体又像流体、既似完整又像破裂的“模糊体”的不确定性概念，因此

能把波函数的本性如薛定谔认为的波动方程中，波场是集中积聚在微小空间内而形成的波群或波包的解释说清楚，也能解决类似“薛定谔猫”佯谬和“EPR佯谬”等许多宏观与微观分野的问题。这就是环量子的多种自旋类似内禀存在的多共轭量子态。

3、自然界是否确实按照环量子三旋理论的规律运行？也可以从量子信息学的角度来参加公开的较量。量子信息学是由于量子特性在信息领域中有着独特的功能，而以量子力学的态叠加原理为基础，成为量子力学与信息科学相结合的研究信息处理的一门新兴前沿科学。量子信息学包括量子密码术、量子通信、量子计算机等几个方面。量子计算的“格点”规范，量子比特可以制备在两个逻辑态 0 和 1 的相干叠加态，换句话说，它可以同时存储 0 和 1。这是环量子的三旋能办到的。这中间类似的所谓“格点规范”、“量子网络”，“固体模型”等，是又回到一种图形描述，而图形对应形状，又有基本的球面与环面之分，因此又与环量子的多种内禀自旋存在的多共轭量子态是相联系的。

潘建伟教授的量子纠缠经典信息处理的最基本单元是比特，即二进制数 0 或 1；而一个按照一定数学规则给出的随机二进制数据串构成一个密钥，经典通信中最难解决的问题是密钥分配问题。如果密钥分配不是绝对保密，经典密码通信也就不可能绝对保密。但郭光灿、潘建伟等科学家开展的研究发现，基于量子力学线性叠加原理和不可克隆定理的量子密钥分配，却可以从根本上解决密钥分配这一世界性难题。虽然目前美国马萨诸塞州技术研究所与洛斯阿拉莫斯国家实验室，研制量子计算机运算器已成事实，但由于没有完备理论的指导，西方量子计算机原理中存在有纰漏。

例如 Neil Gershenfeld 等人阐释量子计算机能同时处于多个状态且能同时作用于它的所有不同状态的量子陀螺原理图时，对量子位不动的几种陀螺旋转，就分辨不清，明显的错误是把陀螺绕 Y 轴的体旋称为“进动”，这是不确切的。其原因是体旋实际比面旋复杂。而这一点却让量子计算机原理研究的专家所忽视，这类量子计算机原理中的纰漏，与量子计算机以量子态作为信息的载体有关。

因为，人们已提出用光子、电子、原子、离子、量子点、核自旋以及超导体中的库珀对等物理系统作为量子比特的方案，这使量子行为与经典物理的联系更紧密，但它也揭示出经典物理概念天生的不足，从而，非引入三旋概念莫属。计算机可以是任何式样的东西，也可以有不同式样的算法。以量子计算机和 DNA 计算机为例，量子计算机利用的基本元件是原子和分子，依据的是电子或原子核的旋转以及量子粒子的奇异特性，即在不被观测的情况下，

量子粒子可以同时向不同的方向旋转。传统计算机采用的是晶体管，利用晶体管的开和关来表示“1”和“0”，即是取定值 0 或 1 的比特进行工作，非 0 即 1。而在量子计算机中，光子可以是水平偏振和垂直偏振的叠加态，原子的自旋可以同时处于向上向下旋转的不确定的“超态”。即量子计算机采用的是量子比特，一个量子比特可以是 0 或 1，也可以既存储 0 又存储 1。在解决问题时，量子计算机并不是依次把全部数字加起来，而是在同一时间把所有的数字加起来。

由于一个二进制位只能存储一个数据，所以几个二进制位就只能存储几个数据。而由于量子叠加效应，一个量子位可以存储 2 个数据，n 个量子位可存储 2 的 n 次方个数据，便大大提高了存储能力。此外，现在计算中基本的逻辑门是“与”门和“非”门，对量子计算机来说，所有操作必须是可逆的，就是说由输出可以反推出输入。因此现在的逻辑门多不能用，而需要使用能实现可逆操作的逻辑门。它就是“控制非”门，又叫“量子异或”门。有了存储信息的量子位，又有了用以进行运算的量子逻辑门，便可以建造量子量子计算机了。其设计思想是把一束激光或者电波照射到一些精心排列的像陀螺一般旋转的原子核上。当波或者波从这些原子上反弹时，它会改变其中一些原子核的旋转方向。分析这些旋转发生了什么改变就能够完成复杂的计算任务。

但以上仅是能处理 1 或 2 个量子比特的逻辑门的单台量子计算机。实用的关键是在两个逻辑门或处理器之间可靠地传输量子数据，这不管是在一台量子计算机内或是要通过量子网络，都是需要的。即必须实现多粒子的量子“缠结”状态，或叫用量子移物的办法解决。当然这也需要有黎曼这样的空间想象力。如果用类似黎曼的想象力来看三旋，即如果用类似黎曼度规符号建构三旋度规，根据排列组合和不相容原理，三旋可以构成三代共 62 种自旋状态，即需要在每一点引进 62 个“数”。而三旋的单动态是 10 个，它们可以包容在 10 乘 10 的方阵中。其实，三旋理论通过孤子演示链的模拟，已能提示自然界的 DNA 双螺旋结构，如何早就在进行相似计算这种最艰难的工作。

1) 量子理论虽然把任何事物包括光、物质、能量甚至时间都看成是以大量的量子形式显现的，并且这些量子是粒子和波的多种组合，以多种方式运动，但量子的拓扑几何形状抽象却长期没有统一。一种认为量子是质点，如类粒子模型；一种认为量子是能量环，如类圈体环量子模型。电子计算机属类粒子模型，因为它的微处理器是以大规模和超大规模半导体集成电路芯片为部件，这是以晶体能带 p-n 结法则决定的电子集群粒子性为基础得以开发

的。而量子计算机则属于类圈体环量子模型，因为一台台式量子计算机的基本元件如核磁共振分光计，它操纵的是量子的自旋，而类圈体环量子模型最具有自旋操作的特色。类圈体的三旋即面旋、体旋、线旋不仅可以用作夸克的色动力学编码，而且也可以用作量子计算逻辑门的建造。因为类圈体环量子的三旋根据排列组合和不相容原理，可构成三代 62 种自旋状态，并且为量子的波粒二相性能作更直观的说明：在类圈体上任意作一个标记（类似密度波），由于存在三种自旋，那么在类圈体的质心不作任何运动的情况下，观察标记在时空中出现的次数是呈几率波的，更不用说它的质心有平动和转动的情况。这与量子行为同时处于多种状态且能同时处理它的所有不同状态是相通的。而这正是量子计算机开发的理论基础，并且能提高计算速度。

例如打开一把有两位的号码锁，在电子计算机中一位的状态由 0 或 1 规定，两位就构成 4 种不同，即 0 与 0，0 与 1，1 与 0，1 与 1；随着计算过程的进行，数据位很有秩序地在众多的逻辑门间移动，因此可能需要进行 4 次尝试才能打开。而一台由极少量的氯仿（ CHCl_3 ）构成的两位量子计算机中，一个量子位可同时以 0 和 1 的状态存在，两个量子位也构成类似的 4 种不同状态，但量子位不需移动，要执行的程序被汇编成一系列的射频脉冲，通过各种各样的核磁共振操作把逻辑门带到量子位那里，该锁只用一步就被打开。

这一切用三旋理论很好理解：类圈体同时能作三旋，设体旋为 0 状态，面旋为 1 状态；线旋类似原子核磁场和外加磁场，它既能作方向定位又能对体旋和面旋方向进行操作，而且是远距离瞬时缠连的同时作用。这如花样游泳运动员在水中除能作各种表演外，还能听令于岸上的指挥。虽然人工制造三旋很难，但三旋却与物质的各个层次都有联系。例如在分子层次可以把 DNA 双螺旋结构看成多重类圈体，在原子层次可以把原子看成单个类圈体。在量子计算机中，至少要用到两个原子，其中一个除起逻辑测定外，这个额外的位还能起内部量子误差自动校正纠错的作用。例如利用氯仿中氢核和碳核类圈体似的三旋之间的相互作用，建造一个量子受控非门：用一个振荡频率为 400 兆赫（即射频）的磁场，可以使被置于 10 特斯拉的恒定磁场（设箭头沿垂线）内的一个氢原子核圈发生体旋。设氢圈的面旋轴向不是朝上就是朝下，即圈面在垂直于恒定磁场的水平方向；设碳圈的面旋轴向确定地朝上，即圈面也在水平方向，当一个适当的射频脉冲加上之后，可以使碳的圈面绕水平方向轴体旋到垂线方向，然后碳圈将绕着垂线方向轴继续体旋，其体旋速度将取决于氯仿分子中氢圈的面旋轴向是否恰巧朝上。而经百万分之一秒的时间，碳圈的面旋轴向

将不是朝上就是朝下，这取决于邻近的氢圈的面旋轴向是朝上或朝下。因为在那一瞬间再发射一个射频脉冲，使碳的圈面再绕水平方向轴体旋 90 度，这样，如果相邻的氢圈的面旋轴向朝上，此操作就使碳圈的面旋轴向朝下；而如果相邻的氢圈的面旋轴向朝下，它就使碳圈的面旋轴向朝上。可见量子计算是借助于类圈体的三旋转动及“受控非门”的操作，因为作为这种逻辑门三旋基础的面旋轴向可以处于朝上和朝下，以及体旋可以绕水平和垂线轴向转动这两种状态的迭加中，因此，量子计算可以同时为一组似乎互不相容的输入进行操作。

2) 超导量子通信系统的基本部件包括量子态发生器、量子通道和量子测量装置。按其所传输的信息是经典还是量子而分为两类。前者主要用于量子密钥的传输，后者则可用于量子隐形传态和量子纠缠的分发。量子力学是非定域的理论，这一点已被违背贝尔不等式的实验结果所证实，因此，量子力学展现出许多反直观的效应。在量子力学中能够以这样的方式制备两个粒子态，在它们之间的关联不能被经典地解释，这样的态称为纠缠态，量子纠缠指的是两个或多个量子系统之间的非定域非经典的关联。利用类圈体三旋模型的多态性和同时性演示，就能教育普及类似量子计算机的量子逻辑。

例如有了能启发寻找量子计算机和隐形传输芯片研制的超导办法、材料、线路的帮助，要研制出精密尖端的隐形传输实物设备，也还是一个系统工程。例如，超导量子计算机和隐形传输互为依存，其线路及运算都离不开图灵和小波分析。

3) 把小波分析看成是基于把物理直观和信号处理的三旋球，作傅里叶级数展开类似的孤子链分析，量子超导隐形传输实现需要小波分析经验建立的反演公式。即影像如被看作是二维信号，信号与影像处理统一看作是信号处理，目的是准确的分析、诊断、编码压缩和量化、快速传递或存储、精确地恢复。孤子链描述采用傅里叶办法，任一函数都能展开成三角函数的无穷级数。但傅立叶分析一般针对稳定不变的信号，隐形传输多数信号是非稳定的。把孤子链每个单独的链圈看成类似小波基概念，非稳定信号处理应用特别适用的小波分析；这是一个时间和频率的局域变换，因而能有效的从信号中提取资讯，通过伸缩和平移等运算功能，对函数或信号进行多尺度细化分析，可以解决傅里叶变换不能解决的问题。因为小波分析，用于边界的处理与滤波、时频分析、信噪分离与提取弱信号、求分形指数、信号的识别与诊断以及多尺度边缘侦测等，有比较成功的方法。如小波包最好基方法、小波网域纹理模型方法、小波变换零树压缩、小波变换向量压缩等，其压缩比高，压缩速度快，压缩后能保持信号与影像的特征不变，

在传递中可以抗干扰。

4、精密尖端的量子信息传输设备，核心是超导体量子计算机。一般来说，无论电脑还是量脑计算，大原则还是都遵循图灵论点：即物理实在的某些部分相似于其它部分，这种相似可以是具体的，如天象仪相似于夜空；它还可以是抽象的，如印在书里的量子理论的一条陈述，正确的解释了多重宇宙结构的某个方面。图灵从这种自相似性描述的原理，引申出存在一台抽象的通用计算机，并使得通用计算机的实现成为可能；它的其全部本领，包括任何物理上可能的对象，所能完成的任何计算。量子链描述的也是虚拟现实，也是通用性物理现象，根据哥德尔不完备性定理，这种逻辑上可能的环境，很多是不可计算的。

1) 把量子链联系康托尔、哥德尔和图灵论点，量子链可以定义为一种通用虚拟现实的生成器，为描绘所有物理上可能的环境服务。在物理环境中，测量必须在有限集中取值，对于有限数字系统，不存在哥德尔式的不可判定性。所以量子链这样的演示机器能存在。把量子链与量子计算机结合，对比电脑，对付太复杂的计算，电脑所需的时间和存储量在理论上是无法得到的，只有量脑能完成。量子链的小波分析加通用量脑对图灵原理的加强，能够描绘虚拟量子现实中任何有限的物理下的环境，所需计算资源也不会随对象的规模和细节呈指数增加，因此能完成其他任何量子计算机所能完成的任何计算。也许有人会问：量子链也会思考吗？因为图灵试验是一种用于判定机器是否具有智能的试验方法，为现代计算机的逻辑工作方式奠定了“图灵机”逻辑的基础。

即图灵机可以看成是一个两端带有无穷带子的黑箱，带子由联成串的方格组成，黑箱和带子由一指针相连。图灵机只有有穷多个状态和有穷多条指令。计算的每一步中，根据机器所处的状态和指针所指的方格上的符号指令，可决定机器干什么事并转入什么状态。开始计算时，机器处于开始状态，然后一步步地根据指令进行计算，当无法继续时停止。带上讯息即为计算的结果。这是一套控制规则。它根据当前机器所处的状态以及当前读写头所指的格子上的符号来确定读写头下一步的动作，并改变状态寄存器的值，令机器进入一个新的状态。注意这个机器的每一部分都是有限的，但它有一个潜在的无限长的纸带。图灵认为这样的一台机器就能模拟人类所能进行的任何计算过程。

把量子链的每个单独的链圈和小波分析的小波基等概念，联系的时间和频率的局域网变换，有效信号中的资讯提取，它对函数或信号进行的多尺度细化分析、伸缩和平移等运算，如果对应图灵机的纸带、带子联成串的方格、符号指令、转入状态、

控制规则、读写头动作、寄存器值等等，也许是和图灵模型、丘奇演算等价的，与作傅里叶级数展开上的递归函数也有关联。所以三旋和量子链变换为可计算函数，有着丘奇-图灵环境图的意义，它可以断定某些问题是不能行地解决或不能行地判定的。

这里关键在于能否证明量子计算可以计算非递归函数。能，则表明它超越了丘奇-图灵论点的界限；不能，则表明它依然受丘奇-图灵论点的制约。因此，任何声称量子计算超越了丘奇-图灵论点界限的人，都必须严格证明量子计算机解决了一个非递归性的问题，否则这种声称就是无意义的或值得怀疑的。自丘奇-图灵论点提出后，人们不是已证实了许多不可计算的问题吗？如一阶逻辑的判定问题、丢番图方程的整数解问题、群论上的字问题、四维流形的同胚问题等；如果哪一天超导量子计算机能够解决这么一个非递归问题，那么人们一定会接受量子计算动摇了丘奇-图灵论点的观点，目前还有许多工作要做，但这是值得商榷的。

2) 因为这是一个悖论。其一，量子计算机现在还根本没有完善出来，既然讨论明确是在理论层面上，而不是在现实层面上，那么量子派要求等到哪一天量子计算机造出来了，并能够解决类似的一个非递归问题，才接受量子计算机动摇了丘奇-图灵论点的观点，可目前还没有，所以量子计算机就不能超越丘奇-图灵论点的界限，这不是违反了量子派自己设立的理论层面要高于现实层面的论证方法吗？其二，既然正式的量子计算机还没有造出来，怎么就知道它不能够解决类似的一个非递归问题呢？其三，如果把人看成类似量子计算机与电脑完美的结合，人不是也可以解决类似的一些非递归问题吗？所以，量子派的反驳，也可以看成是一个量子计算机悖论。量子派所谓量子计算机并没有超越丘奇-图灵论点的界限，只不过量子计算机有着电子计算机不可比拟的计算效率的这种看法，仅是一种表面看法。我们的“双螺旋结构与超导量子计算机”研制说明，判断是属于一种计算，人们从自己的两只手开始，学计算、做计算，两手生理的共轭带来的手征性，能给予我们人类身边许多物质以有效的判断。这联系生命，可以说生命本质上就是一种自组织计算。而超导量子计算机的出现，更从多方面揭开了这个谜底。即超导量子计算机的出现也许能揭示人脑与DNA双螺旋结构的结合，才是更为完善的电脑。

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为《双环结构的宇宙》作序

屠迪先生《笔名夜穹》要我为他的新书《双环结构的宇宙》作序，我感到无比欣慰。

王德奎

四川绵阳

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Abstract: 一种是把奇点看成为不可穿透的球，是一种智慧。一种是直接把奇点扩容到环面，是另一种智慧。我感受很深要说到1958年大跃进，当年在穷乡僻壤的四川盐亭县，由于每个区都办起了初中，招生的扩大使我这个脑子笨的农村孩子也进到中学，受到西方数学和物理学知识的一些启蒙。不想第二年自然灾害就袭来，饥荒中的分切红薯，多想一块红薯可以无限可分下去，越分越多，但刀子不能进入红薯以外的虚空。所以虚空相对实体，实际类似不可穿透的球。

由于有这点原生态的感受，我在半个多世纪的学习能理解西方自然科学在这两种智慧的基础上，完成的整个数学和物理学的现代结构。而且20世纪后期西方的科学家正是基于此，创造了奇点、视界、黑洞等三个概念。但奇点主要还是指环面，这是出于球面与环面直观的区别，在微分几何和拓扑学上称为不同伦。所以当认真读屠迪先生寄来的书稿后，想到他说的“偌大的中国，人口13亿之众，应该有自己的‘原创理论’，没顾及到‘是否能被承认’的后果”时，越看越觉得他的“双环”是奇点的原生态，且精彩自然纷呈。

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一、原生态自然的精彩

上海科技教育出版社2008年出版吴新忠等翻译的波士顿大学物理学史学家、科学哲学家曹天子教授的《20世纪场论的概念发展》一书，讲环面是奇点有两种智慧。

一种是把奇点看成为不可穿透的球，是一种智慧。一种是直接把奇点扩容到环面，是另一种智慧。我感受很深要说到1958年大跃进，当年在穷乡僻壤的四川盐亭县，由于每个区都办起了初中，招生的扩大使我这个脑子笨的农村孩子也进到中学，受到西方数学和物理学知识的一些启蒙。不想第二年自然灾害就袭来，饥荒中的分切红薯，多想一块红薯可以无限可分下去，越分越多，但刀子不能进入红薯以外的虚空。所以虚空相对实体，实际类似不可穿透的球。

由于有这点原生态的感受，我在半个多世纪的学习能理解西方自然科学在这两种智慧的基础上，完成的整个数学和物理学的现代结构。而且20世纪后期西方的科学家正是基于此，创造了奇点、视界、黑洞等三个概念。但奇点主要还是指环面，这是出于球面与环面直观的区别，在微分几何和拓扑学上称为不同伦。所以当认真读屠迪先生寄来的书稿后，想到他说的“偌大的中国，人口13亿之众，应该有自己的‘原创理论’，没顾及到‘是否能被承认’的后果”时，越看越觉得他的“双环”是奇点

的原生态，且精彩自然纷呈。现摘采几朵如下：

1、**粒子是环不是点**。互生的电环与磁环，称为**双环**。**双环可以形象的比喻是变压器。变压器的线圈是电环，变压器的铁芯是磁环。**

1) **双环结构**D环称为**电环**，首尾不相接，在空间它则展开为螺旋线状，是开环状态。C环称为**磁环**，首尾相接，在空间它是管环状的**闭环状态**，如车轮内胎。

2) D环与C环的运动方向相互垂直，并接着电磁感应的右手规则互动。D环在其内部张力作用下沿C环轴向伸展，可以将磁性空间归束为C环。C环沿着赤道散开成苹果状，似抽象的龙卷风。随着D环的展开，空间磁弦向内收拢；在D环的缠绕下空间磁弦完全收拢成为C环，这时的C环已与空间完全封闭。由于D环与C环是共生的，互为因果，所以波动性与粒子性不能分开，**这符合波粒二象互补原理。**

2、**单个双环的运动**，是光子。多个双环的耦合，即可构成各种物理粒子。

1) **空间的电磁环**，电与磁在运动中相互感应、相互翻转，本底能量类似孤粒子对空间的相互作用、相互转化。

2) **光子**类似空间电磁的“龙卷风”，即是光波球。光波是光子把电磁弦不断地向空间发散出去，又收回来的过程，波动是断续的。电磁感应不停的

翻转，光子则不停的向前行进，光是光子的群体效应。

3、自然界中可见到的**双环结构龙卷风**，是大气的扰动、是凝聚能量的载体，是孤粒子。龙卷风，风眼的周围是高速旋转的气流，这是个环状的气流。

1) 这个气流可以抽象为一个环，称为D环。风眼的内部，由下面向上吸入气流。在高于D环时，这股气流开始向空间散开，然后以苹果表面的形状向下，并返回到风眼的下面，如此循环，形成一个稳定的球体。

2) 风眼的上方如同苹果的柄根，风眼的下方如同苹果的花蒂。顺着苹果表皮垂直的由柄根向花蒂切开一个口子，然后沿着苹果的赤道线（柄根与花蒂中间的圆周，如同地球的赤道），向某一点归束起来，也会形成一个环，这个环称为C环。

4、云层中的**卡曼漩涡或涡街**，则类似多个**电磁环耦合的结构**。卡曼漩涡实际上就是一个条形结构的粒子。长条形结构的粒子不稳定，原因是受到碰撞，容易断开。

5、化学物质的分子也多有环形的结构，如：环己烷、芳香族物质。画图多一些形象思维，环作正视图，侧面看，环就是一条直线。

“双环”把**微观基本粒子与整个宇宙从牛顿论、相对论和量子论等传统物理，只是换了个原生态的角度，它的意义也正如屠迪先生所说，这个假设简单、形象，其基本概念及现象的物理意义，是使认知物理更接近本质物理变得简单易懂；它不破坏现有的物理学公式，却能统一能量与时空、宏观与微观、结构与性质之间的关系，解释诸多物理学中难以解释的现象。**

二、模具量子学的自成

曹天子教授在《20世纪场论的概念发展》中说，几何纲领和量子纲领之间虽同为实体，但量子起伏的产生和湮灭，却颠覆了几何图像原有的变化概念。如量子真空起伏的正负虚粒子对的产生和吸收；同位旋概念的费电子交换，电子的真空极化或元激发，或能级跃迁，而出现的虚粒子包括虚电子-正电子对介质的产生和湮灭过程、虚发射和再吸收等被称为的鬼场（ghost field）、鬼态（ghost states）的现象。

据说鬼场、鬼态、鬼圈、鬼顶点、鬼自由度等量子性质实体模拟，难倒了所有大量子物理学家，威滕的弦/M论，斯莫林的圈论，霍金的膜论，才在引领前沿科学新的潮流。而这个潮流的本质是，弦论、圈论、膜论是一种模具模拟。即如果使用的实物模具模拟，还不是量子世界真实面目的忠实描述，那么也是为把所有理论实际存在物，当作只是为了经济描述观测到的现象的相似构造的。屠迪追求使

认知物理更接近本质物理，变得简单、形象、易懂，使用**双环**模具模拟，也许和这个潮流类似。

但我看重屠迪先生的双环编织态，是看到双环很有可扩容挖潜创新。例如，屠迪说**电环D环首尾不相接，为螺旋线状，是开环状态。实际也可扩容为C环磁环的闭环状态**。昂尼斯1914年把铅丝闭合圆环，浸在液氦中降温进入超导态去掉外磁场，圈内感生的循环流动不止的电流就是**闭环状态**。而且它又会沿着圆环自发感生出一组穿流内圈循环流动不止的磁力线。这里**扩容能挖潜创新的是，由于整个磁场其中每一根单独的磁力线也是闭合成圆环的量子，取其中单独的一根磁力线，叫做磁单极量子，实际它是暗物质的候选者。再以整个铅丝闭合圆环感生磁场N和S极取向，磁单极量子的自旋可分为N子和S子两种。根据双环D环与C环互感、翻转共生的理论，由于磁单极量子的存在，类似电子对粒子的四周会存在无数条飞舞的更微观的单链。这类单链还可选择编码，有组成双链式的孤子链的概率。**

由此量子起伏的产生和湮灭类似的真空鬼场、鬼态、鬼圈、鬼顶点、鬼自由度等，就能得到**孤子链模具的演示**。由于磁单极量子涉及暗物质，即使捕捉不到它们，但实验也能测量到它们的物理、化学、生物等效应。所以屠迪的双环说到底，还是类似模具量子学，而且是受到中华民族自古就有这种传统的影响的。例如我国古代自有的“阴阳五行”学说，阴、阳类似具有大小相同、方向相反的能量和自旋的两个电子形成束缚的电子对，这里电子对实际类似一个小环圈；而五行金、木、水、火、土相生相克，实际也类似一个大环圈。因此这种圈论、环论**互感翻转共生，被**称为我国原生态的模具量子学。

像中医“阴阳五行，相生相克”这种孺幼皆知的原生态的模具量子学，即使几千年中在贫穷偏僻的地方，也能给普通老百姓一点实际的好处，并能在新中国创造出对世界抗疟灭疟做出挽救上百个国家数百万人生命发现的**青青蒿素及其衍生物的医学创举**。我支持屠迪模具量子学解**现代量子力学之难，更企盼能创造类似石破天惊的技木。**

寻着这思路来看屠迪的足迹，他说：“在中国，只要有一个基础物理理论能‘成功’，就是胜利！”“《双环结构的宇宙》是个‘形象思维’的产物，与现代理论物理的运作相去甚远，很难得到学院派的认可。与其荒废，还不如作为‘素材’或许还有借鉴作用”。其实屠迪的模具量子学是自成的。我和屠迪并未谋面，认识也只是从2011年3月通过电子邮件开始的。由于我们经历相同，爱好相同，研究相同，观点相同，从他零星的透露中，我能勾画这种模具量子学自成的足迹也许是：

1、屠迪工作在上海，2003年退休在上海。但也

许他出生在东北，那里有一种“穆陵煤”，块大的如半个人头，却很轻；片状的煤可以用火柴直接点燃。在这种煤块上，经常可以看到清晰的树叶痕迹，使他很小就知道煤是树变的。可见他从小就聪慧。

2、上小学时，父亲就给他买了《十万个为什么》、《思索五分钟》、《玩具制造》，以及父亲的电子管、无线电、电动机等书籍和各种工具书，够他看。他也经常玩磁石收音机、模型飞机、焊接铁皮小船、组装磁铁式的直流小电机等等，使他好奇心有增无减。

3、上了中学，开始玩电子管收音机。因此电磁波是怎样在空间传播的问题，始终浮现在他脑中。高中时，兴趣就收敛到了理、数、化。后来接触到了相对论、波粒两相性、基本粒子、时空、黑洞、孤立子等报道。

4、大学后期经历文革……。工作后，《自然杂志》、《高能物理》、《科学画报》，定阅了20多年。他爱好提琴制作，爱好体操、游泳、举重、中长跑等，但对物理学中的一些想法始终没有放弃。

5、他爱好物理，直到2003年退休后才有了“大块”的时间。每天洗衣、烧饭、作家务，还看电视。有时有灵感了，就记录下来或整理一下。这样他将长期以来对基础物理学的探索与研究的心得，几十年积累的结果，加以整理，“东西”从零星凑出产生了一个全新思路的《双环结构的宇宙》书稿。

三、盼石破天惊的技术

屠迪先生说体现本书的价值，是目的面对中学生更具可读性；写成“科普”是为了扩大普及面；书中对基础物理探索的假设和猜想，目的在于唤起普通国人对物理的兴趣，乃至参与探索物理。并说“在国内学术界不学有派，霸气十足的人并不罕见，好像他自己难学的东西别人就必然不懂”。又说“一般的说，物理爱好者如果对物理学涉入较深、时间较长、又建立了自己的一整套理论，那么他无疑会偏爱自己的理论，想要相互‘说服’是困难的”。可见屠迪是很低调和很实在的人。

屠迪先生要我为他写序，也曾称赞我的三旋理论“并不落后于国际主流，是个好的范例”。我先感到惶恐。2002年我积40多年业余探索的成果出版了《三旋理论初探》一书，西方《新语丝》网站论坛发表一篇“深刻”解剖的文章，题目是《一本“旷世奇书”？》，作者是pengxh。他因学习需要查资料，在网站搜索到我的工作环境和经历介绍，感到“作者现在仍然任《绵阳日报》编辑，实在不合情理”。因为他认为现在是个“高校和科研院所都求贤若渴”的时代，“以如此的研究条件做出这样的成就令人生疑”，“作者有欺名盗世之嫌”。

他说该书作序的李后强、金吾伦、刘粤生三位老师中，可恶的是刘粤生说了“这是一部旷世奇书”。他说，不用说中科院院士，“就当时国内的科研大环境和其工作环境来看，有如此建树恐怕不易”，“以如此的研究条件做出这样的成就令人生疑”。他问道：“不知作者的百余篇论文发表在何处。但愿不是《绵阳日报》”。他“唏嘘不已”，“希望真正的专家来客观评价评价这本专著”。pengxh希望已经快十年，刘粤生教授“旷世奇书”的说法，引起不少“反伪”专家的共讨之。Pengxh是代表，他入木三分地总结时代的部分特征是“死要面子的中国人”，没有人能“经住高薪和良好科研环境和条件的诱惑”。

我是第一次给人作序，借此作序我要回答的是，那百余篇论文，没有一篇是发表在《绵阳日报》上的。一个人在基层凭借自己的条件和能力，40多年的日日夜夜把所有的业余时间和爱好，都投入到科学探索上，搞一些模具量子学类似东西，没有什么奇怪的。我曾在人民网强国论坛上发表过一篇博文，题目是《重识易经与生态文明》，其中说：“把正义、非正义与科技创造联系起来组合研究，从远古到现今有八种情况：

- 1、我们用自然、原始的工具打败了侵略者或侵略了别人；
- 2、我们用自己创造的科技原理，自己生产的工具打败了侵略者或侵略了别人；
- 3、我们用别人创造的科技原理，别人生产的工具打败了侵略者或侵略了别人；
- 4、我们用别人创造的科技原理，自己生产的工具打败了侵略者或侵略了别人；
- 5、别人用自然、原始的工具打败了侵略者或侵略了我们；
- 6、别人用自己创造的科技原理，自己生产的工具打败了侵略者或侵略了我们；
- 7、别人用我们创造的科技原理，他们自己生产的工具打败了侵略者或侵略了我们；
- 8、别人用自己创造的科技原理，我们生产的工具打败了侵略者或侵略了我们。

火药、造纸、指南针、印刷术、易经，是我们中国古代人的科技原理到实物的创造，我们强大了十多个世纪。后来火药、造纸、指南针、印刷术、易经传到了西方，西方终于改变这些科技原理，火药变成了现代枪炮，造纸变成了现代音像设备，指南针变成了现代陀螺遥控，印刷术变成了现代信息技术，易经变成了电子计算机。虽然我国目前在这些方面也有科技原理的创造，但我们终究强大不过西方。而近几个世纪，西方更多的还是用自己创造的科技原理，自己生产的工具侵略了我们。因此，我们要自强、自卫，有后劲，要用自己创造的科技

原理，自己生产的工具打败侵略者。这也是杨振宁、陈省身教授他们这些走出国门，获得公认大成就后的中国人，认识到要从本质和方法上改变修身、齐家、治国、平天下的顺序的意义”。

这篇博文，被《中国高校科技与产业化》2004年第12期收入发表，题目改为《吹响重识易经的号角》。我的百余篇论文也正是得到这类国家刊号杂志和杂志领导的主动关爱发表的。我和pengxh先生的人生道路不同，我不反对pengxh等先生死要面子、名利，但我的动力来源对祖国的热爱和对生育养育我那片贫瘠乡土的眷恋。我追求科学理论的创新和

发现，但更追求变成石破天惊的技术。科学原理当然重要，但各人站的角度不同，会出现很多不同的声音，很难统一。所以最后以“盼石破天惊的技术”共勉。

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Land Holding Pattern And Technical Efficiency Of Maize Production In Ogbomoso Agricultural Zone Of Oyo State

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Abstract: The major objective of this study is to analyze the farmland acquisition pattern and technical efficiency in maize production in the study area using a stochastic production frontier. The finding showed some level of inefficiency irrespective of the land holding pattern but more pronounced in the community holding land. The study further examined the determinant of inefficiency in these categories and found out that household size and experience are the major determinant of inefficiency.

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Introduction

The land tenure system defines the relationship among men in the use and control of land resources. A lot of work has been done on land tenure by several researchers and authors, each exclusively deriving a definition about the concept based on the study pattern, personal abilities and philosophy. The word "Tenure" means holding of property, especially real estate or by reference to a superior. When land is "held" it stands to exclude others from its use. Another most important dimension of land tenure is the period of time for which the property is held (Thapa, 1996).

Traditional land tenure systems have proved to be flexible in allowing for differences in the needs of families and for changing circumstances. It has generally been possible for the more energetic and capable farmers to acquire extra land, either from that controlled by the community, pledge. The owner of land has become unsecured due to a growing shortage of land and insecurity of expectations generated by the land policies of the government. Traditional system of land tenure presupposes an abundance of land. However, the existing pattern of land tenure may not evolve quickly enough to avoid acting as a constraint upon agricultural changes, which are urgently required in view of the rising population where it is no longer possible to leave land to fallow and continuous cultivation is now the rule (Fabiya, 1990). Traditional system of land tenure encourages low productivity due to lack of incentives to develop the land, retards agriculture and effective utilization of land.

A substantial amount of agricultural investment is crucial to provide an acceptable standard of living to maize farmers; of all the factors which could be responsible for poor performance of agriculture in Nigeria, land tenure is one. Thus, for the reasons

highlighted above, the Nigerian land tenure system has been under serious problem and pressure. This was exposed by Udoh (2000), when he said with land owners are becoming numerous and land becoming more complex and diversified.

David (1995) further explained that customary land tenure has rendered individual land holder trouble in getting credit as he cannot pledge land which he does not own as security for a loan. In a similar way, Adedipe et al, (1997) explained that such land cannot be used as collateral for securing credit. Credit availability to small holder farmers has been found to be significantly related to the type of land tenure.

Another disadvantage of customary land tenure is that it may be managed by relatives in the village (Adedipe et al, 1997). While the practice of land leasing is advantageous in giving employment opportunities to landless migrant farmers and gives absentee land owners the chance to earn some extra income from rent, it generally does not lead to the best farm management practices. (Ondiege, 1976).

Nigeria's situations on tenure systems need an urgent step which will provide security to farmers and land owners, hence the call for enactment of the Land Use Decree. The above, thus make people especially farmers call for accelerating land tenure arrangement as a pre-requisite for rapid economic and social development.

Before the promulgation of Land Use Decree now Land Use Act (LUA) human merely have the use of land. Under the customary law in most communities in western Nigeria, a well stratified hierarchy of authority and control over land developed, at the apex is the Oba or Baale, followed by the traditional chiefs, and the family heads. (Adedipe et al., 1997).

Although the agricultural policy for Nigeria of 1989 recognizes land as a major factor in crop production, it is evident that land is not readily available, given the magnitude of the requirement, both for agriculture and for industrial development (Adedipe, 1997). Subsequently, the government issued a policy statement which recommended that ownership of all land in the country should be vested collectively in all Nigerians, through the allocation of certificate of occupancy at the local government and state level for rural communal tenure and privately owned land (Adedipe et al., 1997). According to Adedipe et al., (1997), the Land Use Decree (Act) vests all land in the state through the office of the (military) governor of each state. Land is held in trust and administered for the use and common benefit of all Nigerians according to the provision of the Act. By this legal instrument, the state replaced the traditional institutions of Obaship and chieftaincy in their roles as keepers of communal land.

The Land Use Act of 1978 is made up of eight parts of fifty one sections. It addresses four important issues arising from the former land tenure systems in Nigeria: the problem of lack of uniformity in the laws governing land use and ownership; the issues of uncontrolled speculation in urban land; the questions of access to land rights by Nigerians on equal legal basis; and the issue of fragmentation of rural land arising from either the application of tradition principle of inheritance and / or population growth and consequent pressure on land. It approaches these issues via three related strategies; the vesting of proprietary rights in land in the state; the granting of infrastructural rights in land to individuals; and the use of an administrative system rather than market forces in the allocation of rights in land (Thapa, 1996). The solution to the problem of inadequate food production, especially in the face of mounting population pressure and declining soil fertility, rest with increased productivity through intensive use of land and other resources. therefore, this study examined productivity of maize in line with land ownership pattern in Oyo state.

2. Materials and method:

Agricultural productivity can be defined as the index of the ratio of the value of total farm output to the value of the total input used in farm production, (Olayemi, 1980). This index can be measured by using many methods, some of which include: the linear programming method, budgetary analysis, and so on.

The theoretical basis for this study hinges on the production theory and the production function approach. The farmer is identified with his given level of technical efficiency, Price / allocative

efficiency and the overall (economic) efficiency. Since the production process involve an input – output relationship, the production and factor markets play a significant role. Farmers operate in the two markets as price takers.

Resource productivity is definable in terms of individual resource inputs or a combination of them. Optimal productivity of resources implies an efficient synonym in this context.

Farell (1958) has defined efficiency measures in three forms:

- (i) Technical efficiency which measures a firm's success in producing maximum output from a given set of inputs.
- (ii) Price efficiency which measures a firm's success in choosing the optimal set of inputs.
- (iii) Overall efficiency which is the product of these two types of efficiencies i.e. technical and price efficiencies.

2.1 Measurement of Resource Use Efficiency

Farrel (1957) discovered a methodology to measure economic, technical and allocative efficiencies is associated with the ability to produce on the frontier isoquant while technical efficiency refers to the ability to produce at a given level of output using cost minimizing input ratio and economic efficiency simply means the capacity of a firm to produce a pre-determined quantity of output at minimum cost for a giving level of technology.

Bravo-ureta and Pinheiro (1997) using production frontier and second step analysis performed on two-limit to derive equations for technical efficiency and economic efficiency and allocative efficiency were not only able to provide empirical measure of different efficiency indices but also indicated some key variables that are not correlated with these indices. This is going beyond much of the published literature concerning efficiency, because most of the researches in the area of productivity analysis focuses exclusively on the measurement of technical efficiency.

Earlier, Olayide (1982), claimed that the simplest methodology of resource productivity is in terms of individual input-output ratios. For instance, labour productivity can be calculated by multiplying this ratio of the total output to the total input of labour and the indices of productivity can be calculated by multiplying this ratio by 100, in terms of aggregate output-input framework, resource productivity in crop production process.

Bravo-ureta and Pinheiro (1993), tried to identify the sources of inefficiencies in maize farming by investigating the relationship between farm/farmer characteristics and the computed indices of efficiency

which include allocative efficiency, economic efficiency and technical efficiency.

Indices using the model by Bravo-ureta and Pinheiro (1993), based on what the literature called “second step” estimation, they were farm level technical efficiency, allocative efficiency and economic efficiency with variable like; contract farming, agrarian reform, size of farm, years of schooling, age, and number of people in the household. Contract farming was found to be positively related to the indices of efficiency and this is consistent with Kalirajan (1981) who argued that contract farming can be very valuable for small scale operation, because it has access to the market and increases income and employment opportunities. Furthermore, contract farming may improve allocative or price efficiency by reducing risk. Reform was found to be positively connected to the indices of efficiency, Bravo-ureta and Evenson, (1994), found positive connection between farm-level efficiency and the availability of the extension services and access to information between extension and efficiency appears to be findings in the farm efficiency literature focusing on developing country agriculture. (Bravo-ureta and Pinheiro, 1993).

Farm size and indices of efficiency was found to have a positive relationship supporting the notion that medium size farm have an efficiency advantage as compared with small farms and very large farms.

Various studies have found a positive correlation between formal education measured in years of schooling and indices of efficiency (Belbase and Grabowski, 1985) while several others have reported no statistically significant relationship between these two variables (Bravo-Ureta and Evenson, 1994).

Age is positively related with indices of efficiency, which shows that those farmers who are under twenty five years have higher level of technical efficiency, allocative efficiency and economic efficiency. These results are consistent with the findings of Belbase and Grabowski (1985) and Bravo-Ureta and Evenson (1994).

The number of people in the household was found to be negatively significant with allocative efficiency and economic efficiency but positively significant with technical efficiency. The result indicates that larger household might utilize family labour beyond the point where the marginal value product of labour is equal to the wage rate (Bravo-Ureta and Pinheiro, 1997).

In addition, according to Hussain (1989), older farmers are less likely to have contact with extension agent and are less willing to adopt new practices and modern inputs.

Furthermore, younger farmers are likely to have some formal education and therefore might be more successful in gathering information and understanding new practices which in turn will improve their efficiency through higher level of technical and allocative efficiency.

2.2 Sampling Procedure, data collection and analytical technique

The study area has five local government areas, namely Ogbomoso North, and South, Orire, Surulere and Ogo-Oluwa. The multistage random sampling technique was employed. The first stage involved purposive selection of three Local Government areas in Ogbomoso agricultural zone namely; Ogo-Oluwa, Surulere and Orire Local Government areas because of their rural nature. The second stage involves random selection of four villages from each local government area, making a total of 12 villages in all. The third stage involves random sampling of ten maize farmers from each of the twelve villages, making a total of 120 farmers.

2.3 Method of Data Analysis

The data collected were analyzed with the use of three methods (i) Descriptive statistics involving the use of simple percentages and proportions. These were used to examine the socio-economic characteristics of the maize farmers and the Stochastic Frontier Production Function: This was used to estimate the technical efficiency in maize farming. It is given by:

$$\ln Y_i = \ln B_0 + \sum B_j \ln X_{ij} + v_i - u_i; \dots i$$

Where Y_i =Farm output (kg), X_i =vectors of farm inputs use, X_1 =farm size (ha), X_2 =seed (kg), X_3 =Fertilizer (kg), X_4 =Labour (Manday), X_5 =Chemical (litre), V =Random variability in the production, μ =Deviation from maximum potential output attributable to technical inefficiency, β_0 =Intercept, β =Vectors of production function parameters to be estimated; $i=1, 2, 3, n$ farms; $j=1, 2, 3, m$ inputs.

2.4 Model Specification

In this study, the focus is on maize production, which is one of the main food crops in the study area and Oyo State as a whole. With the work of several scholars like that of Seyoum et al., (1998) where the Cobb-Douglas stochastic frontiers was used in estimating the technical efficiency of maize farmers. Therefore, for the sake of this study, the stochastic frontier production functions in which Cobb-Douglas as proposed by Battese and Coelli (1995) represents the best functional form of the production frontier and also as confirmed by Yao and

Liu (1998) was applied in the data analysis in order to better estimate technical efficiency of maize farmers.

The model of the stochastic frontier production for the estimation of the TE in a way consistent with the theory of production function can be specified as follow:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + V_i - U_i \dots \dots \dots ii$$

Where subscript i refers to the observation of the ith farmer, and

Y	=	Output of maize Grain (Kg)
X ₁	=	Farm size (ha)
X ₂	=	Seed (Kg)
X ₃	=	Fertilizer (Kg)
X ₄	=	Labour (Manday)
X ₅	=	Chemical (litre)
β ₀	=	Intercept
β ₁ 's	=	Parameters to be estimated
ln's	=	Natural logarithm
V _i	=	Random variability in the production
U _i	=	Deviation from maximum potential output attributable to technical inefficiency.

The inefficiency model

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} \dots \dots iii$$

Where:

U _i	=	Technical inefficiency of the ith farmer
Z ₁	=	Age of farmer (years)
Z ₂	=	Sex of farmer (dummy; 1 = male, 0 = female)
Z ₃	=	Marital status
Z ₄	=	Year of farming experience
Z ₅	=	Household size

The technical efficiency in equation was simultaneously estimated with the determinant of technical efficiency defined by equation iii to examine the influence of maize farmer's socio-economic characteristics on their technical efficiency. It assumes that the technical inefficiency measured by the mode of normal distribution where U_i is a function of socio-economic factors (Yao and Liu, 1998). In the presentation of estimate for the parameters of the above frontier production, the β and δ coefficients are un-known parameters to be estimated along with the variance parameters δ² and γ. The δ², and γ, coefficients are present. The estimates of the stochastic frontier production function were appraised using the generalized likelihood ratio test, and the t-ratio for significant economic relevance.

3. Result and discussion

Socio- economic characteristics of the farmers, farmland acquisition pattern and technical efficiency in maize production in the study area are presented in Table 1. From the table it was revealed that 47% of the respondents fall between the ages of 36 – 45 years and acquire their farmland by inheritance while only 7.5% of the respondents fall below 25 years which enable them to have community right to acquire their farmland. The mean age was 37.9 years which implies that most of the maize farmers are in their active age; hence, productivity is expected to be high. About 83% of the respondents were male while 17% are female, this implies that male have right to inherit farmland and had a community right to hold a farmland than female, also, about 53% of the respondents are married while only 28% are single, 73.2%, of the respondents had a farm size of less than 1 hectare, 11.2% had between 1 – 3 hectare of farmland, while 8.5% of the respondents had 3 – 5 hectare of farm size and acquire their farmland by inheritance, 13% had their farm size greater than 5 and acquire their farmland by community holding. The findings with respect farm size in this study are in congruent with the findings of Olayide, (1980). Table 1 also reveals the distribution of educational levels of the respondents. The level of education attained by a farmer is known to influence the adoption of innovation, better farming decision making including efficient use of inputs. The study showed that 81% acquired their farmland by inheritance while 12% had access to community holding to acquire their farmland for cultivation. This means that the more educated people acquire their farmland more than respondents with no education which could lead to better management of the enterprise, farming experience as a factor is supposed to have a positive relationship with the productivity of farmers. Approximately 26% of the respondents had between 6-10 years of experience on inherited farmland while 18% of the respondents that acquired their farmland by community holding had 11 -15 years of experience, also 3.4% of the respondents that acquired their farmland had less than 20 years of experience.

The table further revealed that about 57.1% acquired their farmland through inheritance which provide property right to the farmer and permit the farmland to be used for perennial and annual crop cultivation while 28.5% had community right to hold farmland for their cultivation, while 13.3% had privilege to purchase their farmland for cultivation. Also, the showed the distribution of respondents by farm related factors. It shows that only 59% were migrants who serve as labourer to farmer who

inherited farmland, while 29% were settlers who settled in their various villages and serve as labourer to farmer who had community right to holding farmland for cultivation. The survey found that head potorage served as the most popular 62% mean of

evacuating farm produce among the farmers while 30.2% evacuate their farm produce by mean of motorcycle among the farmers that had community right to holding farmland.

Table 4.1: Distribution of respondents by socio-economic characteristics.

Year of Experience	Frequency	%	Frequency	%	Frequency	%
≤ 5	36	62.0	18	40.9	6	33.3
6-10	15	25.8	13	29.5	6	33.3
11-15	5	8.6	8	18.1	4	22.2
≥ 20	2	3.4	5	11.3	2	11.1
Total	58	100.0	44	100.0	18	100.0
Labour (man day)						
Migrant	34	58.6	27	48.2	8	50.0
Settlers	14	24.1	16	28.5	4	25.0
Others	10	17.2	13	28.2	4	25.0
Total	58	100.0	56	100.0	16	100.0
Mode of Transport						
Foot	40	61.5	16	37.2	5	41.6
Motorcycle	12	18.4	13	30.2	3	25.0
Bicycle	8	12.3	10	23.2	2	16.6
More than one	5	7.6	4	9.3	2	16.6
Total	65	100.0	43	100.0	12	100.0

Source: Author's computation.

3.1 The stochastic frontier production function analysis for farmland acquisition pattern and technical efficiency in maize production in study area

This section discusses the results of technical efficiency estimates for the analysis of farmland acquisition patterns (Inherited, community holding, and direct purchase) and technical efficiency in maize production in study area. The Cobb Douglas functional form of the stochastic frontier function provided the best fit based on the explicit analysis of farmland acquisition pattern and technical efficiency in maize production as well as the number of significant variables in the model.

Among maize farmers on inherited land, the only significant variable was seed and these was significant at 1% while the other variables like farm size, fertilizer, labour and chemical were all not significant at all known levels of significance. Seed had the highest coefficient with a value of 0.8666 in preferred models (model 2). Farm size, seed and labour all carried positive signs while fertilizer and chemical both carried negative signs in preferred model. Among the maize farmers on lands acquired by direct purchase, none of the variables like farm size, seed, fertilizer, labour and chemical was significant at all known levels of significance. Fertilizer had the highest coefficient with a value of

0.5536 in the preferred models (model 2). Farm size, fertilizer, labour and chemical all carried positive signs while seed alone carried negative sign in the preferred model.

Among the maize farmers on community holding, the only significant variable was labour and this was significant at 1% while the other variables like farm size, seed, fertilizer and chemical were all not significant at all known levels of significance. Labour had the highest coefficient with a value of 1.080 in the preferred models (model 2). Farm size, fertilizer and labour all carried positive signs while seed and chemical both carried negative signs in the preferred model. The variables with positive coefficient imply that any increase in such a variable would lead to an increase in maize output of the maize farms, while an increase in the value of the variables with a negative coefficient would lead to a decrease in output of maize. Negative coefficient on a variable might indicate an excessive utilization of such a variable.

The estimated sigma squares (σ^2) of the maize farmers on land obtained by inheritance, direct purchase and community holding were 0.9881, 0.9656 and 0.9313 respectively in the preferred model (model 2). The values are large and significantly different from zero (Table 2). They

indicate better goodness of fit of the model and the correctness of specified distributional assumptions.

The estimated gamma (γ) parameters of the maize farmers on inherited, direct purchase and community holding were 0.9881, 0.9466 and 0.8444 and were highly significant at 1% level of significance. This means that 98.8%, 94.66% and 84.44% of the variations in the maize output among the farmers on inherited, direct purchase and community holding in the study area are due to the differences in their technical efficiencies.

3.2 Inefficiency Model

The estimated parameters of the inefficiency model in the stochastic frontier models of the analysis of farmland acquisition pattern and technical efficiency in maize production in study area are presented in Table 2a-2c. Among the farmers on inherited lands, the coefficients of marital status, experience, and household size were negative while those of age and sex were positive. Those variables with positive coefficients lead to increase in technical inefficiency or decrease in the technical efficiency of maize farmers on inherited lands while variables with

negative coefficients lead to decrease in technical inefficiency or increase in their technical efficiency.

Among the farmers on direct purchased lands, the coefficients of age, marital status, experience, and household size were negative while that of sex was positive. Those variables with positive coefficients lead to increase in technical inefficiency or decrease in the technical efficiency of maize farmers on direct purchased lands while variables with negative coefficients could lead to decrease or increase in technical inefficiency or efficiency. Among the farmers on community holding, the coefficients of marital status, experience, and were negative while those of age, sex and household size were positive. Those variables with positive coefficients could lead to increase or decrease in technical inefficiency or efficiency of maize farmers on leased lands while variables with negative coefficients could lead to decrease or increase in technical inefficiency or efficiency.

The estimated productivity parameters such as elasticities of production and returns to scale are discussed in this section.

Table 2: Maximum likelihood estimates for the parameters of the stochastic frontier Production function for maize farmers on inherited lands in the study area.

Variable	Parameter	Model 2	T-ratio
General Model (Production Function)			
Constant	β_0	45.0778	7.2063
Farm Size	β_1	0.5573	0.3883
Seed	β_2	0.8666*	4.3568
Fertilizer	β_3	-0.2365	-1.2413
Labour	β_4	0.8098	0.5920
Chemical	β_5	-0.8552	-1.2667
Inefficiency Model			
Constant	δ_0	-1.8136	-1.1097
Age	δ_1	5.5530*	2.8323
Sex	δ_2	1.4271	0.7847
Marital Status	δ_3	-4.5115	-1.3655
Experience	δ_4	-11.5470	-1.9785
Household Size	δ_5	-0.2707	-1.0757
Sigma Squared	σ^2	233.683*	215.836
Gamma	γ	0.9881*	109.928
Log Likelihood Function	-130.87		
X^2	301.56		
X^2 (0.05, 8)	14.07		

Notes: ** = 5% level (Figures in parentheses are t- values).

Source: author's computation.

Table 2b: Maximum likelihood estimates for the parameters of the stochastic frontier production function for maize farmers on land directly purchased in the study area

Variable	Parameter	Model 2	T-ratio
General Model (Production Function)			
Constant	β_0	5.4392	1.621
Farm Size	β_1	0.0780	0.376
Seed	β_2	-0.1991	-0.433
Fertilizer	β_3	0.5536	0.645
Labour	β_4	0.1986	0.596
Chemical	β_5	0.1778	0.792
Inefficiency Model			
Constant	δ_0	0.7538	1.935
Age	δ_1	-0.0154	-0.449
Sex	δ_2	0.0363	0.192
Marital Status	δ_3	-0.0111	-0.220
Experience	δ_4	-0.0158	-0.682
Household Size	δ_5	-0.000049	-0.276
Sigma Squared	σ^2	0.9656	6.004
Gamma	γ	0.9466	1.000
Log Likelihood Function		-6.2533	
X^2		23.62	
X^2 (0.05, 8)		14.07	

Notes:** = 5% level (Figures in parentheses are t- values).

Source: author's computation

Table 2c: Maximum likelihood estimates for the parameters of the stochastic frontier production function for maize farmers on community holding in the study area.

Variable	Parameter	Model 2	T-ratio
General Model (Production Function)			
Constant	β_0	0.2975	1.963
Farm Size	β_1	0.3159	1.588
Seed	β_2	-0.1400	-1.314
Fertilizer	β_3	0.0902	0.545
Labour	β_4	1.080	8.494
Chemical	β_5	-0.0583	-0.644
Inefficiency Model			
Constant	δ_0	0.6957	3.422
Age	δ_1	0.0047	0.261

Sex	δ_2	0.1198	1.341
Marital Status	δ_3	-0.0245	-0.953
Experience	δ_4	-0.0439	-3.085
Household Size	δ_5	0.00216	2.803
Sigma Squared	σ^2	0.9313	9.391
Gamma	γ	0.8444	0.854
Log Likelihood Function		16.2929	
X^2		21.80	
X^2 (0.05, 8)		14.07	

Notes: ** = 5% level (Figures in parentheses are t- values).
Source: author's computation

3.3 Elasticities (ϵ_P) and returns to scale (RTS) of the analysis of land acquisition pattern and technical efficiency in maize production in study area.

Among the farmers on inherited lands, the estimated elasticities of the explanatory variables of the preferred model (Model 2) show that farm size, seed and labour were positive functions to the factors. This indicates a good use of such variables and they exist in stage I of the production function while Chemicals and fertilizer were negative decreasing functions to the factors which indicate that the use and allocation of those variables were in stage II of the production function – a preferred stage of production.

Among the farmers on direct purchased lands, the estimated elasticities of the explanatory variables of the preferred model (Model 2) show that farm size, fertilizer, labour and chemical were positive functions to the factors. This indicates a good use of such variables and they exist in stage I of the production function while seed was negative decreasing function to the factors which indicate that the use and allocation of those variables were in stage II of the production function – a preferred stage of production.

Among the farmers on community holding, the estimated elasticities of the explanatory variables of the preferred model (Model 2) show that farm size, fertilizer and labour were positive functions to the factors. This indicates a good use of such variables and they exist in stage I of the production function while seed and chemicals were negative decreasing functions to the factors which indicate that the use and allocation of those variables were in stage II of the production function – a preferred stage of production.

Table 3a: Elasticities (ϵ_P) and Returns-to-Scale (RTS) of the Maize Farmers on inherited lands in study area.

EP	Coefficient
Farm Size	0.5573
Seed	0.8666
Fertilizer	-0.2365
Labour	0.8098
Chemical	-0.8552
RTS	1.142

Source: author's computation.

Table 3b: Elasticities (ϵ_P) and Returns-to-Scale (RTS) of the Maize Farmers on direct purchased lands in study area.

EP	Coefficient
Farm Size	0.0780
Seed	-0.1991
Fertilizer	0.5536
Labour	0.1986
Chemical	0.1778
RTS	0.8089

Source: author's computation.

Table 3c: Elasticities (ϵ_P) and Returns-to-Scale (RTS) of the Maize Farmers on community holding in study area.

EP	Coefficient
Farm Size	0.3159
Seed	-0.1400
Fertilizer	0.0902
Labour	1.080
Chemical	-0.0583
RTS	1.2878

Source: author's computation

3.4 Returns to scale (RTS)

The analysis of results in Table 3a-3c shows that the RTS for the analysis of farmland acquisition pattern and technical efficiency in maize production in study area. The RTS for farmers on inherited, direct purchased and community holding types are 1.142, 0.8089 and 1.2878 respectively in the study areas. This indicates that farmers on inherited and community holding are in the increasing return to scale stage of the production system while those on direct purchased lands are in the decreasing return to scale of the production system.

3.5 Technical Efficiency Analysis of Maize Farms in the Study Area

The predicted technical efficiency estimates obtained using the estimated stochastic frontier models for the individual maize farms in the study area presented in Tables 4a to 4c.

Tables 4a and 4c shows the predicted technical efficiency estimates for the maize farmers on inherited, direct purchase and community holding in the study area. The predicted maize farm specific technical efficiency (TE) for the maize farmers' indices on community holding ranged from a minimum of 10.12% to a maximum of 98.55% for the farms, with a mean of 14.42%. Thus, in the short run, an average maize farmer has the scope of increasing maize production by about 85.58% by adopting the technology and techniques used by the best practiced (most efficient) maize farmers. Such maize farmer could also realize 85.36% cost savings (i.e. $1 - [14.42/98.55]$) in order to achieve the TE level of his most efficient counterpart. (Bravo-Ureta & Evenson, 1994)

The predicted maize farm specific technical efficiency (TE) for the maize farmers' indices on inherited lands ranged from a minimum of 12.46% to a maximum of 99.99% for the farms, with a mean of

54.84%. Thus, in the short run, an average maize farmer has the scope of increasing maize production by about 45.16% by adopting the technology and techniques used by the best practiced (most efficient) maize farmers. Such maize farmer could also realize 45.15% cost savings (i.e. $1 - [54.84/99.99]$) in order to achieve the TE level of his most efficient counterpart. (Bravo-Ureta and Evenson, 1994)

The predicted maize farm specific technical efficiency (TE) for the maize farmers' indices on direct purchase ranged from a minimum of 58.63% to a maximum of 89.71% for the farms, with a mean of 55.54%. Thus, in the short run, an average maize farmer has the scope of increasing maize production by about 44.46% by adopting the technology and techniques used by the best practiced (most efficient) maize farmers. Such maize farmer could also realize 38.15% cost savings (i.e. $1 - [55.54/89.81]$) in order to achieve the TE level of his most efficient counterpart. (Bravo-Ureta & Evenson, 1994)

A similar calculation for the most technically inefficient maize farmer on community holding land reveals cost saving of about 87.73% (i.e., $1 - [10.12/98.55]$) shown in table 4.15. The decile range of the frequency distribution of the TE indicates that about 9.09% of the maize farmers had TE of over 70% and about 6.06% had TE ranging between 51% and 70% respectively.

A similar calculation for the most technically inefficient maize farmer on inherited land reveals cost saving of about 87.54% (i.e., $1 - [12.46/99.99]$) as shown in table 4.16. The decile range of the frequency distribution of the TE indicates that about 24.32% of the maize farmers had TE of over 70% and about 18.91% had TE ranging between 51% and 70% respectively.

A similar calculation for the most technically inefficient maize farmer on direct purchase reveals cost saving of about 34.72% (i.e. $1 - [58.63/89.81]$) as shown in table 4.17. The decile range of the frequency distribution of the TE indicates that about 25.49% of the maize farmers had TE of over 70% and about 33.33% had TE ranging between 51% and 70% respectively.

3.6 Test of hypotheses

The results from the test conducted on the specified null hypotheses are discussed in tables below.

Test of hypothesis for the absence of inefficiency effects

The null hypothesis specifies that the maize farmers on inherited, direct purchased and community holding were technically efficient in their production and that the variation in their output was

only due to random effects, which are beyond the control of the decision maker and as such the average response function (OLS) was adequate to estimate the production function parameters. The hypothesis is defined thus: $H_{02}: \gamma = 0$

The generalized likelihood ratio test was conducted and the Chi-square (X^2) distribution was computed. Table 5 shows the results of the generalized likelihood ratio test for the absence of technical inefficiency effects. The results showed that the null hypothesis, $\gamma = 0$, was rejected for the maize farmers on inherited, direct purchased and community holding respectively in the study area. This indicates that the technical inefficiency effects were strong in the production of maize by the farmers having different land ownership statuses in the study area and that variation in their production processes were not only due to random effects but also inefficiency effects.

Table 4a: Decile range of frequency distribution of technical efficiencies of the maize farmers on community holding in the study area.

Decile Range (%)	Technical Efficiency	
	Frequency	%
≤ 30	38	54.54
31 – 40	6	18.18
41 – 50	4	12.12
51 – 60	2	6.06
61 – 70	-	-
71 – 80	1	3.03
81 – 90	1	3.03
>90	1	3.03
Mean %	14.45%	
Minimum%	10.12%	
Maximum %	98.55%	

Source: author’s computation.

Table 4b: Decile Range of Frequency Distribution of Technical Efficiencies of the Maize Farmers on inherited land in the study area.

Decile Range (%)	Technical Efficiency	
	Frequency	%
≤ 30	30	2.70
31 – 40	5	13.51
41 – 50	6	16.21
51 – 60	2	5.40
61 – 70	5	15.51
71 – 80	1	2.70
81 – 90	1	2.70
>90	7	18.92
Mean %	54.84%	
Minimum%	12.46%	
Maximum %	99.99%	

Source: author’s computation

Table 4c: Decile range of frequency distribution of technical efficiencies of the maize farmers on direct purchase in the study area.

Decile Range (%)	Technical Efficiency	
	Frequency	%
≤ 30	4	5.88
31 – 40	5	9.8
41 – 50	9	17.65
51 – 60	7	13.73
61 – 70	10	19.60
71 – 80	7	13.73
81 – 90	6	11.76
>90	-	-
Mean %	55.54%	
Minimum%	58.63%	
Maximum %	89.81%	

Source: author’s computation

Table 5: Test of hypotheses on technical efficiency

H ₀₂ : Maize farmers are fully technically efficient ($\gamma = 0$)						
Farmers’ land status	L (H ₀)	L (H _a)	X^2 Computed	d.f	X^2 7, 0.05	Decision
Inherited	-121.46	-106.39	301.56	8	14.07	Reject Ho
Direct purchase	-48.94	31.65	23.62	8	14.07	Reject Ho
Community holding	-65.57	16.2929	21.80	8	14.07	Reject Ho

Source: author’s computation

Conclusion:

This study examined the productivity of maize farmers with respect to the pattern of land holding using a stochastic production frontier. The findings of the study have implications for increased food production in the study area. Attainment of 70% efficiency means that farmers still have room to increase their efficiency to the optimum (100%). This will require addressing those factors which are constraints to efficiency. In conclusion, there is a significant positive relationship between farm size, fertilizer, seed and labour in the maize output in the study area and also access to good quality seed have positive impact on output, and increase in size of production brings better output to the farmers. To make farmers more efficient technically, adult education should be encouraged to introduce modern techniques of farming to improve productivity. Hence, maize production in the study area is profitable.

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Determinants Of Urban Charcoal Demand In Ogbomoso Metropolis

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Abstract: The study analyzes urban households demand for charcoal within the context of overall household cooking fuel consumption, with specific objectives of estimating the respective proportion of expenditure of the main cooking fuel types in total *fuel expenditure* and describing the household and fuel characteristics which determine demand for charcoal in urban areas. The study employed the use of cross-sectional data from urban households survey conducted on a sample of two hundred households from ten communities in the area. The data were collected with the aid of structured questionnaire and analyzed using descriptive statistics and Almost Ideal Demand System Model estimated by Ordinary Least Square Regression. It was observed that educational level, household size, electrification status and assets significantly determined the charcoal demand in the study area.

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Key word: charcoal, almost ideal demand system; fuel

Introduction

Wood fuels (charcoal and fuel wood) play a significant role in the fuel requirements of many developing countries especially Nigeria where there is an increasing dependence due to growing urban population coupled with limited accessibility to the modern alternative fuels. The report of Food and Agriculture Organization (2005) indicates that extraction of trees for wood fuels accounts for sixty one (61) percent of total wood removal globally and that hundreds of millions of people remain completely dependent upon wood for fuels.

In developing countries, wood fuels contribute to 83% of total energy consumption (World Energy Council, 2004), and in the case of charcoal, Africa consumes over 50% of the world's total production of which Nigeria alone consumes about 16%, majority of this charcoal is consumed in urban areas by households for cooking and heating.

In several energy policy documents in Nigeria, it is desirable that household will over time experience a transition from charcoal to more modern fuel types such as kerosene and gas. This transition has not occurred as charcoal has become an increasingly dominant fuel for urban households. Charcoal has remained the most common cooking fuel in Nigeria, and over the year, charcoal supply/demand imbalance in some parts of the country has adversely affected the economic well-being of the people. On the national level, increasing charcoal consumption contributes to deforestation with consequent land degradation and soil erosion.

The widespread and increasing popularity of charcoal among Nigerian urban households is as result of rapid urbanization, high population growth, inadequate supply of the modern alternative fuels at

prices which consumers can easily afford, fall in the real income of urban dwellers due to declining economic condition and availability of charcoal at relatively cheaper prices. The situation now in Nigeria is that thousands of bags of charcoal enter most of our urban centres on daily basis every year and these add up to quite a large tonnage of charcoal per year for which trees had to be cut from forest.

In Nigeria the four main cooking fuels used in urban centres are charcoal, fuel wood, kerosene and Liquefied Petroleum Gas (LPG), however, there is a situation of erratic supply of modern fuels (kerosene and gas) and availability of charcoal at relatively cheaper prices, many urban households therefore see the use of charcoal as an alternative way out of this problem of inadequate supply of the modern alternative fuels, hence there is massive shifting to the use of charcoal among urban households, a situation which in turn leads to increase in demand for charcoal among urban households. This increase in demand however has devastating impacts upon the forests, the rural supply areas and agriculture. Adverse impact that are already apparent but which would increase if the trend continues are: soil erosion, less biomass available for all other uses, traditional economic forest products such as fruits, nuts, medicinal trees becoming scarce, and more land being opened for cultivation but fall in agricultural productivity.

Therefore, considering the overall effect of this problem and the need for better understanding of the situation, this study examined the proportion of cooking fuel expenditure in total household expenditure and estimates the respective proportion of expenditure of the main cooking fuel types in total fuel expenditure.

2. MATERIALS AND METHOD:

Chambwera (2004) developed an urban household energy consumption framework in analyzing the urban fuel wood demand among households in Zimbabwe. The energy mix model used as a framework captures the reality that household use multiple energy sources and that the use of different energy sources is associated with several indicators of socio-economic status such as income, household size etc. In addition to the presentation of the physical combination of different energy sources, the framework also presents energy consumption in terms of relative expenditures on different sources of energy. According to him, household fuel wood demand has its basis in household quest to meet their basic livelihood requirement through energy consumption together with other commodities. However, for the scope of this study which is the analysis of urban household charcoal demand within the context of overall household domestic cooking fuel, electricity is not considered as a fuel and will not be included in the framework. Therefore, the framework to be used in this study will be the fuel mix model. This conceptual framework presents the households fuel consumption mix as being influenced by a set policy levers, which include:

- a) Household characteristics such as household size, income, value of the fuel-using appliances e.t.c
- b) Fuel characteristic such as prices, availability, and convenience.

When a particular fuel mix is considered, the negative effects on the forests, in form of reduction in the availability of economic forest products will be determined through the amount of charcoal in the mix.

In term of expenditure, the ultimate decision of all households is about how much of its total fuel expenditure to allocate to each fuel to achieve maximum satisfaction. The total fuel expenditure will depend on several factors such as income and other household factors.

The allocation of Total Fuel Expenditure (TFE) to individual fuel type will be done in such a way as to maximize fuel utility of household subject to its fuel outlay, the price of the fuels and other factors. The overall household consumption of different household goods and services shall first be considered, fuel will then be assumed to be a compound commodity, which can be broken into its separate components of the different fuel types such as kerosene, charcoal, gas, and fuel wood.

In Nigeria, kerosene, charcoal fuel wood and gas are the principal domestic fuel types in urban areas, therefore, these are the fuels considered in the framework for an analytical purpose. They are the different fuel types that households mix to satisfy their domestic fuel requirement in urban centres.

When fuels of different types are measured in a common unit e.g Mega Joule, (Mj), the household fuel consumption scenario can be put as

$$TQF = Q_c + Q_k + Q_g + Q_f \dots\dots\dots(1)$$

Where TQF denotes total quantity of fuel consumed (in Mega Joules).

Q_c , Q_k , Q_g and Q_f denote quantities of charcoal, kerosene, gas and fuel wood respectively, all measured in MJ.

To translate these into their respective physical quantities, these appropriate conversion factors of UNEP (1991) fuel density factors can be used.

Charcoal	1kg =	31MJ
Kerosene	1L =	35MJ
Gas	1Kg =	23MJ
Fuel wood	1kg =	16MJ

In term of expenditures the household fuel consumption scenario can be put as:

$$TFE = E_c + E_k + E_g + E_f \dots\dots\dots(2)$$

Where TFE is the total fuel expenditure by a household.

E_c , E_k , E_g and E_f are household expenditure on charcoal, kerosene gas and fuel wood respectively.

Total fuel expenditure itself is expressed as a share of total household expenditure such that.

$$\omega_{TFE} = \frac{TFE}{TE} \dots\dots\dots(3)$$

where ω_{TFE} is the share of total fuel expenditure in total household expenditure TE.

The share of each fuel in the expenditure mix is a ratio of its expenditure and total fuel expenditure such that for all fuels in the mix, these ratios add to unity $\sum \omega_i = 1$.

Where w_i is the share of fuel i defined as;

$$w_i = \frac{E_i}{TFE} \dots\dots\dots(4)$$

E_i is the expenditure on fuel i which can be expressed as

$E_i = p_i q_i$, and TFE is the total household fuels expenditure

$$w_i = \frac{P_i q_i}{TFE} \dots\dots\dots(5)$$

Therefore, Following Chambwera (2004) approach, the quantity of fuel i consumed can be estimated from the above expression as follow

$$q_i = \frac{\omega_i TFE}{P_i} \dots\dots(6)$$

And specifically for charcoal, the expression becomes

$$q_c = \frac{\omega_c TFE}{P_c} \dots\dots(7)$$

The work of Falcao (2002) was on the analysis of the price of fuel wood and charcoal in markets of Maputo city, using the existing wood fuel data. The average nominal prices of charcoal, fuel wood, kerosene and minimum salaries per year since 1985-1997 as well as the consumer price index and inflation rate were compiled from literature. The decade trend of real prices of charcoal and fuel wood was estimated based on regression analysis and exponential model. Alastair (2007) explored the socio-economic role of charcoal and the potential for sustainable production with variety of social science research methodologies such as Participatory Rural Appraisal, with semi-structural interviews combined with transect walks through the charcoal producing districts, as well as a resource mapping exercise to learn about the community's resource base. The analysis of the livelihood and charcoal data involved the use of descriptive statistics, graphical representation and regression analysis to investigate the relationship between kiln inputs and outputs and in order to determine kiln efficiency and conversion rates, which could then be applied to estimate production rates for calculating sustainable production.

Mulenga (2002) combined both statistical and econometric analysis in his empirical strategy to investigate and analyze the demand for and substitution possibilities of charcoal in urban Zambia. The finding suggests that own price, price of kerosene, household income, size of household, size of dwelling and high cost of charcoal substitutes are some major factors that explain the demand for charcoal among urban households in the area. It illustrates further that substitution to more efficient energy forms such as electricity is weak and constrained by lack of funds to pay for electricity connection as well as monthly tariffs. The coefficient of the own-price elasticity is negative, significant and elastic while the coefficient of the household income elasticity is negative, weak, significant and inelastic. A situation which implies that while charcoal is a necessity for most of the households it is also an inferior goods.

The demand for all forms of energy, according to Gamtessa (2002), are price elastic, and cross-price relation indicates that kerosene is a substitute for both

charcoal and fuel wood while electricity is a substitute for all the three. In his multivariate analysis of the consumption pattern there are findings that the probability of consuming traditional fuels in general declines with increase in income and the prices of the traditional fuels whereas it increases with the increase in prices of the modern fuels. The probability of consuming modern fuels increases with increase in income and prices of the traditional fuels and declines with an increase in modern fuels prices.

There are many other empirical literatures that concentrate on estimates of wood fuel demand with wide variety of coverage such as African, Asian urban, and rural, higher and lower income groups. Examples include Edmond (2002), Gupta and Kohlin (2003), Amacher *et al.* (2004), Baland *et al.*, (2005), and Chaudhuri and Fall (2003). The summary of such studies by Hyde and Kohlin (2002) indicated that the range of own price elasticity of demand found is -0.11 to -1.47 with only one of ten estimates greater than 1 in absolute value. The prices used in the studies range from market prices to various measures or indicators of households shadow prices for wood fuels.

Comparing the findings from Kebede *et al.*, (2002) on analysis of demand for several fuels among several urban households in Ethiopia with that of Chambwera (2004), there is a consistency as indicated by the negative values of the own price elasticities, and the cross price elasticity of kerosene and fuel wood showed that they were direct substitutes and their combination is an inferior substitute of electricity.

2.1 Sampling Procedure and Sample Size

A multistage sampling technique was used to select a total of 200 households needed for the study. First the two Local Government Areas of the metropolis were purposively selected because of their urban nature. These are Ogbomoso North and Ogbomoso South Local Government Areas. The second stage of the sampling involved random selection of five (5) communities, through balloting system out of the ten (10) communities in each of the Local Government to make a total of ten (10) communities. At the third stage, fifty percent of the total households in each of the selected communities were randomly selected.

The primary data needed for the study mainly centre on at-home consumption of charcoal and other cooking fuels (Kerosene, fuel wood, and LPG) together with other household attributes. The use of a structured questionnaire was made as an instrument for the collection of the data, and this was conducted among a sample of 200 households selected according to the sampling procedure. The

questionnaire was administered to heads of households but in the absence of the head of the household, other members of the household such as spouse and grown up child who can provide the required information were interviewed.

2.2 Data collection and analytical technique

Data on household characteristics collected include sex of the head of the household, educational level measured in term of year of schooling, age of the head of household, size of the household, ownership of the house, electrification status of the house, value of all fuel-using appliances possessed by the household, while expenditure data include total expenditure and total fuel expenditure of the households.

Data on the price of charcoal is required to determine the actual quantity consumed given its budget share and expenditure. This charcoal price data was collected separately from the household survey though the data pertains to the same period as the household survey. Charcoal price data was collected from the selling points in a cross-sectional price survey carried out in the entire city covering 50 selling points.

Linear Approximate form of Almost Ideal Demand System (LA-AIDS) in order to determine the relationship between the budget share of each fuel, and the total fuel expenditure, fuel prices faced by households and household characteristics. The OLS regression analyses were carried out using the Limited Dependent Variable/Software (LIMDEP 7.0) package.

2.3 Model Specification

The linear approximate form of Almost Ideal Demand System Model to be estimated is specified according to Deaton and Muellbauer (1980) as follow:

$$\omega_i = \alpha_i + \beta_i \ln(TFE/P^*) + \sum \gamma_{ij} \ln P_j + \phi X + U_i$$

.....(8)

Where

ω_i are the share of household expenditure on fuel i in the total fuel expenditure

α_i = the average value of the budget share of fuel i in the absence of price and income effects.

β_i = effects of total fuel expenditure on the budget share of fuel i.

P_j = the price of fuel j

γ_{ij} = effects of the price of fuel in group j on the budget share of fuel i

TFE = the total fuel expenditure

P^* = the price index

X = the vector of household characteristics with corresponding co-efficient vector ϕ

U = an error term

The above specified system is the Almost Ideal Demand System model which estimates the shares of expenditure of different fuels including charcoal in total fuel expenditure and how these shares change as fuel expenditure, prices and household characteristics changed. The model was estimated in the analysis using household survey data.

2.4 Variable Definition

The various variables used in estimating the AIDS model are defined as follow:

Educ :- Educational level of the household head.

Sex :- Sex of the household head (Male = 1, Female = 0).

Hhsize :- Household size (Number of individuals in the household).

Elec ::- Electrification status of the house in which household lives (Electrified = 1,

Unelectrified = 0).

Room :- Number of room used by household.

LnAsset :- Natural logarithm of value of fuel using appliances possessed by household.

LnTfe :- Natural logarithm of household monthly fuel expenditure.

Own :- Ownership of house.

Pc :- Price of Charcoal.

Pf :- Price of Fuel wood.

Pk :- Price of Kerosene.

Pg :- Price of Gas.

Wc :- Share of charcoal expenditure in total fuel expenditure.

Wf :- Share of fuel wood expenditure in total fuel expenditure.

Wk :- Share of kerosene expenditure in total fuel expenditure.

Wg :- Share of gas expenditure in total fuel expenditure.

Result and discussion:

This section presents the empirical results of estimations carried out using the model earlier presented. According to this model, households decide how to allocate their fuel budgets to different fuels in the fuel mix.

The estimations results recorded a good fit with the Durbin-Watson (DW) statistic showing no significant evidence of autocorrelation. The values of the R^2 for each of the budget share equations show that about 52.8%, 85.5%, 85.3% and 95.7% changes in the budget shares of charcoal, fuel wood, kerosene and gas respectively are as a result of the changes in the independent variables. All parameters estimates

jointly tested for each of the budget share equations are significantly different from zero as evident by F statistic.

This is estimated as a system of equations, determining the shares of each fuel in the fuel mix given household total fuel expenditure, the relative prices of the fuel paid by different households and other household characteristics. Table 1 gives the results of the estimations of the fuel expenditure shares of different fuels together with the overall statistics and an indication of the variables that are statistically significant.

The results from the table show that the level of education (which according to Huang *et al.*, (2000) is a measure of social status) recorded a negative but significantly impact on the budget share of charcoal at 10% probability level, but it has no significant relationship on the budget shares of kerosene, fuel

wood and gas. This shows that as the level of education increases, households allocate less of their fuel budgets towards the purchase of charcoal, which is a wood fuel. This according to Chambwera (2004) shows that the perception of charcoal as an inferior fuel is higher among more educated household than among less educated ones. Increase in education level according to Huang *et al.*, (2000) determines both the level of exposure of a household to different technologies, styles of life and social status in the society. This increase in the level of exposure positively influences households' preference for the modern fuels but negatively influences their preferences for the wood fuels. Guatemalan studies by ESMAP (2003) also show that better educated households are more likely to move away from wood fuels than less educated ones.

Table 1: Shares of individual fuels

Variable	W _c	W _f	W _k	W _g
Constant	-.331 (-.997)	.790 (4.376)	-.042 (-.132)	.584 (3.911)
Sex	.003 (.076)	-.032 (-1.390)	.015 (.372)	.014 (.723)
Edu	-.005(-1.842)*	-.001 (-.775)	.005 (1.517)	.001 (.658)
Hhsize	.054(1.652)*	.023 (1.170)	-.098(-2.769)***	.020 (1.230)
Hhsizesq	-.006(-1.482)	-.002 (-1.048)	.009 (2.769)***	-.002 (-1.013)
Own	-.030 (-.805)	.023 (1.116)	-.034 (-.943)	.041 (2.472)**
Room	.025(1.532)	.001 (.062)	-.012 (-.753)	-.014 (-1.860)*
Elec	.051 (.821)	-.035 (-1.041)	-.037 (-.615)	.022 (.770)
LnAsset	-.006 (-.243)	-.044(-3.057)***	.056 (2.197)**	-.006(.483)
Pc	-.171(-5.987)***	.072 (4.616)***	.051 (1.840)**	.049 (3.792)***
Pf	.124 (2.906)***	-.295(12.781)***	.163 (3.968)***	.008 (.421)
Pk	-.001 (-.014)	-.004 (.233)	-.002 (-1.550)	-.002 (-.132)
Pg	.242 (2.328)***	.011 (.191)	.227 (2.255)**	-.480(-10.249)***
LnTfe	.032(1.344)	-.002 (-.173)	-.051(-2.132)**	.020(1.787)*
R ²	.528	.863	.861	.960
D.W	1.924	1.774	1.760	1.842
F	19.09	108.02	106.03	405.80

Source: author's computation

Figure in parenthesis are t-values.

***, ** and * represent significance at 1%, 5% and 10% respectively.

Household size is only significant in the budget share equations of the two fuel types, that is, charcoal in which it is significant at 10% level with a positive relationship and kerosene in which it is negatively related to its budget share at 1% probability level. This pattern as observed in the budget share equations of charcoal, fuel wood and kerosene follows the fuel consumption pattern in India, which is also a developing economy similar to Nigeria, according to Filippini *et al.*,(2004) which reveals that larger households consume less modern fuel than smaller households. Evidence from

Guatemala (ESMAP 2003) also confirms this pattern. The sign of the coefficient of the square of the household size is however positive and significant in the budget share equation of kerosene. This reveals the U curve characteristics of kerosene which explains the fact that when household size initially increases, the decline in the consumption of kerosene consumed for uses such as cooking is larger than the increase in the quantity of kerosene consumed for other uses such that the share of kerosene initially decline, however as household continues to increase, the number of household members who need

kerosene for the minor uses increases and the absolute amount of kerosene in total expenditure starts to rise, again, following a U curve pattern.

The value of fuel – using appliances recorded a 1% significant relationship in the budget share equation of fuel wood and a 5% significant relationship in the budget share equation of kerosene with a negative relationship in the budget share equation of fuel wood and a positive relationship in the budget share of kerosene. The relationship however in the budget share equations of charcoal and gas is negative and insignificant. The implication of this is that the share of kerosene increases as the value of fuel-using appliances used by household increase but the share of fuel wood in total fuel expenditure decreases with increase in the value of the fuel using appliances. Thus, access to more appliances enables households to use more kerosene. This finding agrees with finding from Chambwera (2004) and Gebreegziabher (2007). This is likely to be as a result of availability of more of appliances that use more of kerosene because the types of fuel using appliances possessed by households affect the extent to which households use a particular fuel (Linderhof 2001).

Total fuel expenditure is found to be significant at 10% level for gas budget share equation and at 5% level for kerosene budget share equation. It is negatively related to the budget share of kerosene but positively related to the budget share equation gas. This indicates that increase in the households' fuel expenditure will cause them to allocate more of such fuel budget to gas and less of it to kerosene purchase. For charcoal, the positive sign of the coefficient of Total Fuel Expenditure (although not significant) is consistent with the result from Mulenga (2002), while for kerosene and gas, the results agree with the results from Chambwera (2004) This therefore classifies kerosene as a necessity and charcoal and gas as luxuries among the households in

the area. This pattern may be as a result of the reported inadequate supply of kerosene and availability of charcoal at relatively cheaper prices in the area.

The coefficient of the price of charcoal is significant in the budget shares equations of the four fuels with an expected negative sign in the budget share of charcoal and positive sign in the budget share equations of the other three fuel types. This implies that increase in the price of charcoal will cause households to reduce the budgetary allocation to charcoal and increase their budgetary allocation to fuel wood, kerosene and gas.

The price of fuel wood was found to be significant in the budget share equations of charcoal, fuel wood and kerosene. It however has an expected negative sign in the budget share equation of fuel wood. This implies that an increase in the price of fuel wood will cause households to increase their budgetary allocation to charcoal and kerosene but reduce their budgetary allocation to fuel wood.

The price of gas recorded a 5% significant positive relationship in the budget share equation of charcoal and kerosene, and expected negative relationship in the budget share equation of gas, which is significant at 1% level. This indicates that an increase in the price of gas cause households to allocate more of their fuel budget to charcoal and kerosene and less of it to gas.

It is therefore evident that household characteristics such as educational level of the household head, household size and the fuel characteristics such as prices of charcoal, fuel wood, and LPG are very important in determining household budget allocation to charcoal among urban households.

Estimation Of Own And Cross Price Elasticities of Charcoal

Table 2: Marshallian Own price and cross price elasticities of charcoal.

Quantity changes	Price changes →			
↓	Charcoal	Fuel wood	Kerosene	Gas
Charcoal	-1.40	0.26	-0.03	0.51
Fuel wood	1.04	-5.21	-0.31	0.16
Kerosene	0.17	0.38	-0.95	0.52
Gas	1.98	-0.07	-1.44	-25.02

Source: author's computation

The estimated parameters of the AIDS equation form the basis of elasticities which are important for assessing the impact of policies on quantities demanded. The Marshallian (uncompensated)

elasticities are reported, and the estimates of Marshallian own price and cross price elasticities given below in Table 2 shows that the own price elasticities of charcoal, fuel wood, kerosene and gas

are found to be negative, consistent with theoretical expectation and the magnitude very high which is an indication that they are elastic and sensitive to changes in their own prices. This is consistent with elasticity estimates from Ethiopia (Kebede *et al.*, 2002) and Zimbabwe (Chambwera 2004).

The estimates of cross price elasticities of fuel wood, kerosene and gas in response to the changes in the price of charcoal show prevalence of substitution between charcoal and fuel wood, charcoal and gas and charcoal and kerosene. The estimates of Marshallian elasticities shown on the table 2 above therefore indicate that 10% rise in the price of charcoal will increase the demand for fuel wood, kerosene and gas by 10.4%, 1.7% and 19.8% respectively.

The estimates of cross price elasticities of charcoal, kerosene and gas in response to change in the price of fuel wood indicated that 10% rise in the price of fuel wood will increase household demand for charcoal and kerosene by 2.6% and 3.8% respectively while it will decrease household demand for gas by 0.7%. For kerosene, the estimates of cross price elasticity showed that a 10% increase in the price of kerosene will cause households to reduce their charcoal, fuel wood and gas consumption by 0.3%, 3.1% and 14.4% respectively. The estimates of cross price elasticity of charcoal, fuel wood and kerosene showed that a 10% rise in the price of gas will cause 5.1%, 1.6% and 5.2% increase in the quantities demanded of charcoal, fuel wood and kerosene respectively.

The results from the test conducted on the specified null hypotheses are shown in the table below. It was observed that educational level, household size, electrification status and assets significantly determined the charcoal demand in the study area and have the expected signs

Table 3: Test of significance of coefficients of the socio-economic variables

Variables	Coefficients	T- ratio
Sex	.330	.076
Educational level	-.005	-2.842
Household size	.054	2.652
Owner ship	-.030	-.805
Number of room	.025	1.532
Electrification status	.051	3.821
Asset value	-.006	-4.430
Constant	.032	1.344

Table 4: Test of significance of coefficients of the price variables.

Variables	Coefficients	T- ratio
Price of charcoal	-.171	-5.987
Price of fuel wood	.124	2.906*
Price of kerosene	-.001	-.014
Price of gas	.242	2.328**
constant	0.32	

The result of Table 4 revealed that of all the price variables, only the price of kerosene was not statistically significant in the budget share equation of charcoal. The prices of charcoal, fuel wood and gas were statistically significant, therefore, the null hypothesis was accepted for the price kerosene and was rejected for the prices of charcoal, fuel wood and gas.

CONCLUSION:

This study empirically analyzed the household charcoal demand by urban households within the context of overall household cooking fuel consumption using an Almost Ideal Demand System. The following conclusions were drawn based on the major findings of the study. It was observed that the households in the area allocate about 12% of their total expenditure to cooking fuels purchase which could further be broken down to 47%, 7%, 44% and 2% to charcoal, fuel wood, kerosene and gas respectively. The average quantity of charcoal consumed per month by an household in the study area is about 46.4kg. This provides a view of the current status of charcoal demand in the urban area.

It was observed that educational level, household size, electrification status and assets significantly determined the charcoal demand in the study area and have the expected signs

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宇宙量子从郭汉英到黄志洵的反潮流

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Abstract: 《科技日报》2011 年 11 月 9 日, 发表中国传媒大学信息工程学院教授、博士生导师黄志洵先生的文章《欧洲科学家的超光速实验和中国科学家的责任》说: 2011 年 9 月 22 日关于以意大利人为主的科学团队用实验发现中微子能以超光速飞行的报道出来后, 我国十几位科学家进行了讨论并写出了建议书: 我国不可能也不必要跟在欧洲人后面走, 应当搞具有中国特色的、创新的超光速研究。黄志洵教授认为: 实现超光速宇宙航行非常困难, 但并非毫无希望。无论如何, 航天专家有这样的梦想和希望是可以理解的, 在百年前谁又曾想到人类可以在月球(甚至火星)上漫步? 黄教授说得很恳切, 事关国家利益, 是可以理解的。但正因事关国家利益, 就更应该追求国家利益的最大化, 因为关于“科学观”的多种方向选择, 选择错了, 即使“不必要跟在欧洲人后面走”, 国家利益也会受损; 选择对了, 相反相成, 相辅相成, 既可实现“不必要跟在欧洲人后面走”, 又可实现国家利益的最大化。这是中国传统说的“相反相成, 相辅相成”。

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一、相反相成, 相辅相成之师

《科技日报》2011 年 11 月 9 日, 发表中国传媒大学信息工程学院教授、博士生导师黄志洵先生的文章《欧洲科学家的超光速实验和中国科学家的责任》说: 2011 年 9 月 22 日关于以意大利人为主的科学团队用实验发现中微子能以超光速飞行的报道出来后, 我国十几位科学家进行了讨论并写出了建议书: 我国不可能也不必要跟在欧洲人后面走, 应当搞具有中国特色的、创新的超光速研究。黄志洵教授认为: 实现超光速宇宙航行非常困难, 但并非毫无希望。无论如何, 航天专家有这样的梦想和希望是可以理解的, 在百年前谁又曾想到人类可以在月球(甚至火星)上漫步? 黄教授说得很恳切, 事关国家利益, 是可以理解的。但正因事关国家利益, 就更应该追求国家利益的最大化, 因为关于“科学观”的多种方向选择, 选择错了, 即使“不必要跟在欧洲人后面走”, 国家利益也会受损; 选择对了, 相反相成, 相辅相成, 既可实现“不必要跟在欧洲人后面走”, 又可实现国家利益的最大化。这是中国传统说的“相反相成, 相辅相成”。

1、中国一部分主流科学家“实现超光速宇宙航行”之梦, 包含有一种反爱因斯坦及其相对论的不懈情结。这没有错, 但如何实现相反相成, 相辅相成的国家利益最大化, 我国有无数的经验可交流。在国内, 研究爱因斯坦及其相对论, 因资料的

缺乏, 以及历史人文环境因素的影响, 很多学者的研究不很全面, 常给人以隔靴搔痒的感觉。但这仍是一件好事, 好就好能教人看清应该走的方向。2008 年上海《科学》杂志第六期发表郭汉英先生的《我们的宇宙与德西特相对论》, 是一篇挑战文章, 背景涉及德西特相对论已出现的全息、全景式发展。国际上这种类似的万马奔腾, 不亚于我国民科挑战爱因斯坦的波澜壮阔。轻松跨越爱因斯坦, 德西特还说不上。我们能轻松跨越爱因斯坦吗?

近半个多世纪以来挑战爱因斯坦成了我们推动纯科学发展的动力。特别是 21 世纪开始互联网在我国的普及, 广大民科的参与, 形成波澜壮阔的声势。但大多数民科集中在挑战爱因斯坦的光速有限和时空弯曲的直观层面上, 真正算是深层次的还是像郭汉英先生这类拿德西特相对论来较量的专业科学家。但我们认为推动纯科学的发展, 不在于对与错, 而应重在参与。这对民科是这样, 对专业科学家也是这样。参与的目的, 在于信息增殖, 相反相成, 相辅相成。

国内的“相反相成, 相辅相成”之师以“层子”战略为例, 郭汉英先生的父亲, 是我们尊敬的郭沫若先生, 也是新中国科学院的第一任院长。上世纪 60 年代我国三年自然灾害结束后, 郭沫若先生协助国家领导人指引我国第一流的专业科学家队伍, 以“层子”战略推动纯科学的发展, 也是有贡献的。北大教授胡宁院士在 1977 年第 3 期《科学

通报》上说：“层子”是按辩证观点的微观粒子既是点又不是点，以及坂田昌一很早已经提出的所有微观粒子都是由三种更“基础”的粒子所组成的假设布阵的。

到1994年，当时中央主持工作的领导同志，指示科学出版社和中共中央党校出版社联合出版了《现代科学技术基础知识》的干部教材，书中肯定了“夸克”标准模型，没有再提层子，但这项层子工程实际是使我国得到了实惠的，如北京正负电子对撞机的成功，以及在国防和经济中的高能物理的运用等例子，就是证明。而我们正是从那时“层子”观点的普及中，参与了“大量子论”的思考，“层子”观点也为“大量子论”加了油。

2、郭汉英的德西特之问

巧的是，同在2008年和在上海科技教育出版社出版的曹天予的《20世纪场论的概念发展》一书，在第一篇“几何纲领”的三章中，有一大半内容也是讲有关“爱因斯坦与德西特的论战”的史料。曹天予和郭汉英的弟弟郭世英在1962年都是北京大学的同学。把郭汉英与曹天予的说法对照，可知国内与西方的主流科学家，60多年来一直走在相对论和宇宙学基础研究的“两极”。即使在改革开放后，国内一部分主流科学家从宇宙无限论转身宇宙大爆炸论，但并没有因为我国改革开放而改变这种“两极”。按大众的说法，这是“反潮流”；按黄志洵等教授的说法，这是我国“不可能也不要跟在欧洲人后面走”。按我们的想法这应相反相成，相辅相成。

爱因斯坦与德西特的论战的实质，一直延伸到郭汉英的宇宙论中，如果说精心挑选的德西特相对论中，联系D膜和反D膜大量子论映射的德西特空间及反德西特空间，来分析一直延伸到黄志洵等教授为“实现超光速宇宙航行”之梦，其实质还是要主观除去，自然界客观存在实数与虚数领域类似点外空间与点内空间之分的事实。大跃进，我们主观为的是多快好省地建设社会主义；无产阶级文化大革命，我们主观为的是反修防修。说来都是为国家利益，但客观上都没有实现国家利益的最大化。原因很多，从纯科学上说，也许那时大多数人，还没有认识到实数与虚数领域类似点外空间与点内空间之分客观存在的事实。因为在虚数领域，超光速众所周知。

王飞跃教授说，四百年前，虚数刚出来的时候，不被认为是实实在在的“数”，英文是“imaginary number”，直接翻译过来就是“想象的数”。但是今天人人都知道，虚数是实实在在的数，是数的一半，不多不少50%。没有了虚数，一个简单的一元二次方程都可以“无解”，有了它之后，才能有“解”。有解无解差别很大，量子力

学、相对论的推导和数学就是建立在这个差别之上的。如果没有虚数，今天许多计算机程序就要停下来，也就没有了今天的信息产业了。所以，虚数半点不虚！因此，王飞跃教授又说，将来的空间，除了物理空间，还有一个虚拟空间。今天的网络空间，是它的雏形，将来人类生活的空间50%是物理空间，还有50%是虚拟空间，如同数的一半是实数、一半是虚数一样。只用实数，许多简单的数学方程无解，同样，只考虑物理空间，不利用虚拟空间，许多复杂的问题就更无解了。就像方程要有解需要虚数一样，复杂系统要有“解”，必须引入相应的“虚数”才可以——“知必虚而解”，这就是我们的基本想法。认识到这一点非常重要。

但王飞跃教授研究的倾向是“未来世界与未来科技”，或“未来世界的复杂性”中实现国家利益的最大化的应用，目的主要在管人、管物、管社会安全，并没有研究过德西特相对论中联系的D膜和反D膜大量子论，即D膜和反D膜大量子论映射的德西特空间及反德西特空间中，涉及到的实数与虚数领域类似点外空间与点内空间之分客观存在的事实。

王飞跃教授说：“物质上的共产主义不可避免，人类将有更多的时间从事人文、心理和精神方面的活动。研究如何促进科学、技术和人文的交融，以人文引导科技进步，以科技促进人文发展，进而促进网络虚拟社会的发展，应当是一个十分重要的研究领域”。但王飞跃教授没有认识到实数与虚数领域类似点外空间与点内空间之分这一点也非常重要，因为没有这一点，他的“物质上的共产主义不可避免”，就像大跃进、无产阶级文化大革命，难以实现人类利益的最大化。

因为物质上的共产主义，不可避免联系未来世界与未来科技或未来世界复杂性涉及的能源、材料和环境问题。例如，利用夸克海、夸克海的相变的未来科技能源，以及它们能在未来世界量子隐形的传输，这一点正涉及实数与虚数领域类似点外空间与点内空间之分的QCD和量子色动化学的理论实验探索。所以郭汉英的德西特之问，是抓住了“钱学森之问”的牛鼻子。

郭汉英说，早在1970年，著名学者陆启铿就建议考虑常曲率时空的狭义相对论，1970年代初以他为首的中国学者开始就这些问题进行研究。近年来，与超新星、微波背景辐射各向异性观测数据结合，进一步开展研究，并取得一些有意义的成果。郭汉英把它总结为两条路线斗争：一条以爱因斯坦为代表，“把伽利略惯性原理扩充到庞加莱惯性原理，建立了狭义相对论；然后他放弃惯性原理，以广义协变原理和等效原理为基础建立广义相对论，并进而研究宇宙论。在取得一系列辉煌成功的同

时，也带来一些困惑或不得不回答的问题”。另一条则以他和他的战友们为代表，“延续从伽利略相对性原理到庞加莱相对性原理的发展，进而发展为常曲率时空的惯性原理；考虑惯性原理及其对称性的局域化，描述引力相互作用，并与宇宙相联系。这样，就应该有三种相对论，即三种狭义相对论及其局域化”。按郭汉英的说法，爱因斯坦至少有3方面错误：

1) “为了描述引力，也为了避免惯性原理的循环论证，爱因斯坦放弃了惯性原理，提出等效原理和广义协变性原理，认为惯性力与引力等效，并试图在加速运动与惯性运动之间也建立相对性”。

“虽然在广义相对论中，时空几何不再是绝对的，但并没有实现马赫的思想”。

2) “广义相对论建立不久，爱因斯坦提出宇宙学原理，认为宇宙空间在大尺度上大体是均匀各向同性的。为了建立静态宇宙模型，他引进了可有可无的宇宙常数。尽管失去了预言宇宙膨胀的机会，但仍开创了现在的标准宇宙学。随后，在哈勃等对星系退行大量观测数据的推动下，他又放弃了宇宙常数”。“还有其他重要问题，如奇点问题、量子化问题,等等”。

3) “由于惯性系和局域惯性系是一致的，演化的宇宙在确定惯性系的同时，也就确定了局域惯性系。然而，广义相对论却不是这样”。“精确宇宙学已经揭示、并将进一步证实：德西特相对论更好地描述我们的宇宙”。

郭汉英先生力挺德西特，的确德西特对爱因斯坦的挑战是全面的，而且爱因斯坦一生中也是在不断地修正自己的研究观点。但总的说来，爱因斯坦坚持旧唯物主义，反对唯心主义。德西特主要还是在完善广义相对论中的“视界”辩证法，强调除点外空间外，还有类似点内空间的反德西特空间的存在，从而形成了“爱因斯坦-庞加莱-德西特-霍金智慧”。

正是在这条智慧链的主流发展中，郭汉英和他的战友的智慧被边缘化。因为如果这不是事实，那么“钱学森之问”难道不成了“钱学森悖论”？反之，如果郭汉英把德西特空间和反德西特空间看成只类似是在点外空间才实在的那种智慧，能成为世界大师吗？人能活万万岁不死吗？

德西特与爱因斯坦论战是众所周知的事实，但几十年来国际科学主流并没有把这个事实当成是德西特要打倒爱因斯坦，再踏上一只脚，而公认为德西特与爱因斯坦的论战，是他们两人都在为实现相反相成，相辅相成的人类利益最大化负责，这个铁的事实就是曹天予先生说的“爱因斯坦-德西特的论战是相对论性宇宙学出现的直接原因”。在我国强调阶级斗争的年代，有一种说法：“出生不由自

己选择，但表现是可以自己选择的”，即强调不能站错队。在量子论和相对论形成时期的20世纪前后，正是无产阶级和资产阶级的革命斗争风起云涌的开始。社会科学分裂反映在自然科学的分裂，是枪杆子里出政权。唯物主义随之也有枪杆子里出“科学”的权威。

当然，国家利益和国家利益最大化与人类利益最大化，科学最终是一致的。但不站错队，策略也是有的。因为纯基础科学涉及一些普适原理，正是枪杆子里出“科学”争夺的对象。所以西方也有人说，搞量子论和相对论是一件危险的事情。而科学研究没有制度性保障，就类似今天说的不要铁饭碗“下海”一样。电视连续剧《下海》中有一个情节，是下海后的陈志平遇到“投标”中的潜规则，陈志平去找那里分管的最高领导书记谈话思想。书记没有正面回答陈志平的疑难，但给了他一种智慧说：“坚持并活着，就是胜利”。这种智慧反映在郭汉英的德西特之问中，爱因斯坦-德西特的论战虽说是相对论性宇宙学出现的直接原因，但也可以看出它发展的轨迹。

这就是，爱因斯坦-庞加莱-德西特-霍金“下海”，是生活在资本主义社会。由于他们的“出生不由自己选择，但表现是可以自己选择”，在看到反剥削、反压迫的人民的强大革命斗争的正义和成功一面的同时，也看到“冷战”推波的阶级斗争的残酷。为了坚持并活着是胜利，爱因斯坦在超光速问题上，保险地选择了旧唯物主义，把虚数领域的超光速舍弃。庞加莱在表达“庞加莱猜想”时，保险地只选择说了球面的非奇点性，没有完整表达说出环面和空心球存在奇点性。

但即使他们采用了这种保险策略，仍遭到革命导师的批判。德西特看似穷追猛打爱因斯坦和庞加莱，却为霍金、彭罗斯等大批相对论性宇宙学大师的出场奠定了道路。而郭汉英和他的战友的漂亮转身，从郭汉英和郭世英兄弟的智慧的同一，也可看出中国学者相反相成，相辅相成对科学的贡献。

3、国外的“相反相成，相辅相成”之师

胡自民先生说：“仅仅满足于国内小圈子内的认可，相信不是大多数人的目标。毕竟，只有得到国际同行之间的尊重和认可，才是真正的科学研究追求之路”。现以中国学者曹天予在英美十年苦苦搜寻20世纪场论发展研究的材料，说明德西特挑战爱因斯坦与郭汉英的想法各异。

爱因斯坦的光速有限和时空弯曲有没有问题呢？郭汉英的文章《我们的宇宙与德西特相对论》没有明说，而是在光速有限和时空弯曲的图景中提出有三种相对论，即有三种狭义相对论及其局域化。郭汉英说：“精确宇宙学揭示，宇宙尺度的物理学应以极小的正宇宙常数为标志。这应受到高度

重视。”我们理解郭汉英先生的意思，不是号召我国的民科和专业科学家队伍，沿着“层子”观点把爱因斯坦打到，而是沿着德西特认真学习爱因斯坦的道路，为推动 21 世纪的纯科学发展作出新贡献。但郭汉英先生并没有说清楚反德西特空间与类似的“点内空间”的联系，而是背道而驰强调正宇宙常数为标志与类似的“点外空间”的联系，而这正与爱因斯坦同保险。

精确宇宙学的揭示，需要宇宙学有精确描述的数学方程，更需要从该方程求出精确的宇宙学解。爱因斯坦只完成了第一点，第二点却做得不够；他多半一生是靠普及哲学作解释，所以在“马赫解”与“非马赫解”之间徘徊。马赫解类似点外空间联系的正实数宇宙时空，非马赫解类似点内空间联系的负实数和虚数宇宙时空。曹天子把爱因斯坦的宇宙模型定名为“系统 A”，类似驳斥了郭汉英的说法“广义相对论中并没有实现马赫的思想”。

1) 曹天子提供了两个史料。一是 1917 年是十月革命成功年，那时爱因斯坦通过拒斥空穴论证的推广相对性原理的数学描述，很快得出广义协变形式爱因斯坦场方程。但遭到克雷奇曼等评论家的拒绝。虽然克雷奇曼不能严格证明，广义协变方程表达的相对性原理，只是对于没有物理内容的数学表述的一个要求，但 1918 年 3 月，爱因斯坦还是在他的两个相对性原理和等效原理之外，第一次把“马赫原理”作为广义相对论的第三个主要表述列入第三条原理。二是马赫原理作为解的外部约束，预设了物质体是决定时空结构，甚至存在的唯一独立物理实体，而不是作为广义相对论的本质组成部分，这又使爱因斯坦在其晚年也不欣赏马赫原理。从 20 世纪 20 年代中期开始拒绝了这个前提。

曹天子澄清爱因斯坦关于马赫原理的立场，认为爱因斯坦事实上存在两个马赫原理：MP1 与 MP2。被马赫与早期爱因斯坦所坚持，而被后期爱因斯坦所拒绝的 MP1，代表宣传可称重物体完全决定时空的存在和结构的唯一物理实在。MP2 是爱因斯坦在统一场论时期所坚持的，宣传时空在主体论上隶属于由总体实物场代表的物理实在。MP1 与 MP2 的区别，爱因斯坦是把场而不是可称重物体看作给出时空的存在并决定时空结构的终极本体。1952 年 5 月 12 日爱因斯坦给玻恩的信中说：“即使完全不知道光线的偏转、近日点进动、光谱线的移动，引力场方程仍然是令人信服的”。

2) 曹天子说爱因斯坦后来的立场，精神实质仍然是马赫的。系统 A 的意思就是爱因斯坦认为，“构想没有物质的世界的可能性，是不会令人满意的”。郭汉英说爱因斯坦“引进了可有可无的宇宙常数”，“又放弃了宇宙常数”。宇宙常数联系类

似的点内空间和非马赫解，这正是德西特穷追猛打爱因斯坦要说明的宇宙模型；于是曹天子把德西特的宇宙模型定名为“系统 B”。

爱因斯坦为了剥夺旋转的绝对性，追随马赫，求助于难以捉摸的遥远质量。这个策略受德西特的尖锐批评。1917 年德西特提出“超越观察范围之外的一切推断都是靠不住的”。德西特不是在做物理哲学家，而是具体去从爱因斯坦引力场方程，求出精确的宇宙学解。德西特发现马赫原理作为宇宙结构的唯一约束动机，宇宙常数 λ 项的引入既不是必要的，也不是充分的。即使修正场方程放弃了宇宙常数，仍然有非马赫解。德西特的求解表明，当时间也被相对论化以后，即使一个系统被剥夺了物质，仍然能够得出修正后场方程的解。该系统由德西特系统 B 来标志。

3) 德西特在 1917 年的记录，爱因斯坦对模型 B 是否定的。爱因斯坦给德西特的信中，坚持在星体之外不存在世界物质。1917 年 8 月 8 日的第 5 封通信中，爱因斯坦的论证是：“德西特系统无论如何无法描述一个没有物质的世界，而只能描述一个物质完全集中在表面 $r = \pi R/2$ （德西特空间的赤道）上世界。”德西特也论证了赤道不是“物理上可达的”，因为一个粒子只能在“无限的时间之后到达那里，即它根本不可能到达那里”。演化宇宙的观念使非马赫解被人们接受，但为了有一个连贯的理论，1964 年惠勒提出，马赫原理应当被设想为“将爱因斯坦场方程可允许的解，从物理上不可接受的解中分离出来的边界条件”。所以曹天子说，时空的马赫概念尽管有不同的含义，系统 A 与系统 B 分享着共同的特征：两者都是宇宙的静态模型。

沿着德西特的挑战和计算方法，国际主流精确宇宙学得到发展，如施瓦西、勒梅特、爱丁顿、钱德拉塞卡、哥德尔、克尔、惠勒、彭罗斯、柯斯林、霍金等科学家也独立作过类似计算，把演化宇宙推进到奇点、视界、黑洞、暗物质、暗能量等认识阶段。这当中难能可贵的是，早在 1922-1924 年社会主义国家的前苏联的气象学家弗里德曼，在作严格求解爱因斯坦引力场方程中，证明了系统 A 与系统 B 只是具有正的但变化着的物质密度的场方程的无数多解的极限情形：它们中一些解是膨胀的，另一些解是收缩的，这依赖于制衡过程的细节。而在 1925-1927 年勒梅特研究德西特模型时，也提出了一个模型，它的过去与爱因斯坦渐近，而未来则与德西特宇宙渐近。总之，在德西特模型中，解 $r = \pi R/2$ 处的表面的视界本质被接受了；在施瓦西解中 $r = 2Gm/c^2$ ，是在有限时间不可达与不可穿透的观点也被接受了。

可见广义相对论引力场方程只类似一座金矿，看你开发不开发，怎样去开发。但枪杆子里出

科学的冷战视界，爱因斯坦相对论性宇宙学长期被看成是资产阶级的腐朽、没落的象征，弗里德曼的学生G·盖莫夫等一批科学家受到冲击，流亡到西方。从21世纪深入到第三次超弦革命，德西特相对论已不只是在宇宙常数上“小打小闹”，而郭汉英先生仍指责广义相对论的惯性系和局域惯性系的不一致来看，也许他在去世前既没有做过像弗里德曼那样严格的求解爱因斯坦引力场方程，也还没有读通过德西特宇宙模型。

二、德西特演化宇宙模型的延伸发展

相对论性宇宙学引申出的“视界”讨论，是实践论和矛盾论在科学里纠缠的新长征。

德西特 (de Sitter, 1872-1934)，荷兰数学家和天文学家，是研究现代宇宙论最早的学者之一，并且是最先对爱因斯坦相对论深感兴趣的人之一。正是德西特的报告到了英国爱丁顿手中，在英国才普及了相对论，为1919年日蚀期间英国考察队检验广义相对论铺平了道路。但德西特本人对反德西特空间的认识，并没有达到21世纪对反D膜研究的高度。这当然不能苛求德西特，况且德西特本身就坚持“超越观察范围之外的一切推断都是靠不住的”的观念。牛顿以绝对时空表达引力的超距作用，但超距作用实质等价于超光速时空。马赫坚持旧唯物主义，以水桶旋转实验表达世界物质的惯性，反击牛顿的绝对时空，但世界物质惯性作用的瞬时性，仍然是超距作用。

所以德西特反对爱因斯坦追随马赫的宇宙观念，他推论其中的有一点是，光线的弯曲如果是因受到引力，那么任何光线会最终弯得越来越厉害，而有重又回到它的起点的。即宇宙由“弯曲空间”构成。所以弗里德曼认为系统A与系统B，只是具有正的但变化着的物质密度场的性质，即在实数领域变化着。而开始爱因斯坦只觉得宇宙半径是不变的，并且宇宙是静止的，大小不变。德西特则坚持认为，广义相对论可以得到更适当的解释，以便说明曲率增长得越来越少，同时弯曲宇宙象一个正在长大的气泡不断膨胀。按照哈勃的解释遥远恒星的光谱，证实了这一点。而爱因斯坦最后，也转到德西特的观点上来了。

1、人类真正对系统A与系统B，认识存在点内空间和点外空间类似虚数和实数集合的复空间的第一人，来自庞加莱。曹天予说，这是1905年庞加莱对正确掌握狭义相对论至关重要的思想。庞加莱选择长度和时间单位，使得光速 $c=1$ ，他证明洛仑兹变换形成了一个李群。他把这个群表示为四维时空的线性变换群，它混合了时间和空间坐标，但保持了二次齐式 $S^2=t^2-x^2-y^2-z^2$ 的不变性。庞加莱注意到，如果用复值函数(it)取代t，这样

(it, x, y, z)就是四维空间坐标，那么洛仑兹变换只不过是这个空间绕着原点的转动。

1)有人说，庞加莱被公认是19世纪后和20世纪初的领袖数学家，是继高斯之后对于数学及其应用具有全面知识的最后一个人。庞加莱是最后一个数学大家，直觉主义者。如果把庞加莱与马赫比较，马赫只否定绝对空间，庞加莱则既否定绝对空间，也否定绝对时间，还否定绝对运动，否定对在不同地方的同时事件的直觉；类似马赫的四倍。我们以庞加莱的复值函数四维空间坐标为例，设想绕着转动的原点，类似正立方体的房子。一般的学者只想到绕着房子外面的前后左右上下6方的转动。甚至把复值函数，也只想成绕着房子外面的前后左右上下的正负组合。这都与点外空间类似。但如果设想把正立方体扩大一倍，成为超立方体，原来的小立方体就类似点内空间的房子里面的原点，其绕着原点的前后左右上下6方的转动，就类似虚数的世界。这只是其一。其二，房子本身有内外，点外和点内的前后左右上下6方也可以各自虚实组合。

2)庞加莱数学，如何回采相对论性宇宙学？首先要解决数学和物理学的关系。1902年庞加莱出版了《科学与假说》一书，庞加莱的认识是：既然在数学和物理学中发生了明显的分裂性的变化，科学作为一个整体在本质上是经验的，而非先验的。如果不借助智力体系的设想，无声的事件将永远不会变成经验事实。一个科学理论，除了经验性假说以外，必定还涉及基本的或本质的假说或公设。与经验性假说不一样，后者作为理论的基本语言，是约定选择的结果，不是偶然的经验发现。经验事实可以决定性地影响经验假说的命运，但只是在一种选定了的语言框架之内。原理物理学与渴望发现终极成分以及现象背后隐机制的中心力物理学不同，原理物理学旨在阐述数学原理，这些数学原理能够把在两个以上竞争性理论基础上取得的经验成果系统化，能够表达普通的经验内容以及这些竞争性理论的数学结构。因此这些数学原理对不同的理论解释保持中立，容许其中的任何一种理论。

3)爱因斯坦相信庞加莱的这种普适原理和约定认识论，1933年他在牛津大学演讲时说：经验可以提示合适的数学概念，但是既然自然是最简单的可想象的数学观念的实际体现，那么纯粹的数学建构，提供了理解自然想象的钥匙。爱因斯坦这实际已经建构了自然全息论，可以用来回采德西特解中 $r = \pi R/2$ 和施瓦西解中 $r = 2Gm/c^2$, $r = 0$ 等解释。如何理解呢？用庞加莱复值函数四维空间的数学回采德西特空间极值世界的视界，自然全息可以把宇宙的奇点、视界、黑洞类比一个人的生与死一生。人死，类似进入黑洞；但作为生命视界，它等于0又不等于0。因为人刚死，尸骨未寒，外形与

活人区别不大，这类似 $r = \pi R/2$ ， $r = 2G m/c^2$ ；尸骨甚至连墓室都完全风化不存在时，才类似 $r = 0$ 。从这里不难区分点内与点外空间，即人死类似进入点内空间。那么点内空间仅仅是在物质自身内吗？这是一个复杂性问题。例如人的自杀是一种死亡现象，自杀的人可以从高楼上跳下，这说明点内空间不一定全在物质自身内，点外处处都存在，并且就在近旁。但自杀并不是人类社会或人群普遍愿意干

的现象，所以它的概率近乎为 0，类似宇宙学常数。

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Growth as a Prerequisite for Sustainability

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Abstract: A highly developed economy cannot adopt a zero growth situation. According to chaos theory, in such a developed economy there must be a continuous process of inventions and innovations in order to prevent a collapse of the existing socioeconomic structure.

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Keywords: economy, zero-growth, chaos, logistic evolution, innovation, instability, inventions, vitality, revolution

1. A Biological Analogy

In economics we are used to biological oriented concepts, e.g., the growth of population, of production and of national income. There is currently concern about these growth processes; we fear there will be a collapse if growth continues unchecked and that mankind will go the way of the dinosaurs or of the mammoths. Zero growth, therefore, seems to be an ideal policy goal for society, since it apparently offers the only escape from further plundering of our planet and from total disaster. Recently, a diametrically different view has emerged. It holds that it is zero growth and zero innovation that are to be feared, because they would lead to immediate disaster. "Zero growth" involves three problems or dangers. The first one is the problem of the distribution of production, i.e., the partition of the "national pie". During previous affluent periods, growth made these problems easier to deal with since most of us could feel or see an improvement in our standard of living, even without changes in the distribution of income.

Hence, less conflict was experienced than had been encountered in other times, when more for one meant less for others. The discords between farmers and landowners and between workers and capitalists are well known examples. In a zero-growth scenario, many of these old conflicts would return. With less income, and with greater antagonism about the distribution of income, there would be less willingness to make sacrifices for improving the environment and nature. This is also the second concern or danger. We may say, therefore, that a highly developed economy requires some growth to face the challenges of serious problems arising from the distribution of wealth and from the environment.

A small part of growth arises from capital accumulation, but most is derived from increased

productivity. It is here that we see the third danger. Production cannot be limited to existing levels without destabilizing society. It looks simple. We have enough, why not stop at this level? Perhaps this might be possible in a much simpler society; in such a world we need not to curb production. However, in the real world, if we were to limit production to a no growth pattern, we would witness a collapse of our socioeconomic system and destroy our children's future, thereby achieving the very effect we wish to avert.

A. Logistic Growth

Growth may be expected to become restricted; growth tends to decrease with the attainment of higher levels of production. The typical level of production (Y) depends on its logistic growth pattern over time (t). This can be formulated as:

$$Y_{t+1} = kY_t - bY_t^2 \quad (1)$$

Economic development depends on the coefficients k and b , where k is the rate of growth and b is indicative of the resistance to worsening conditions or of the vulnerability of the industry in question. The higher the value of k , the more competitive the industry will tend to be. By setting $y = Y(b/k)$ we obtain the standard logistic growth curve:

$$y_{t+1} = ky_t - ky_t^2 \quad (2)$$

in which y varies between 0 and 1 and k between 0 and 4. The logistic curves derived from Equation 2, for different values of k , are the simple parabolas depicted in Graph a of Figure 1. As the value of k increases from 2.5 to 4.0, for example, the parabola steepens but its form does not change very much.

This implies that no significant differences exist between these four situations.

However, the time series exhibited in Graphs b, c, d, and e of Figure 1 convey completely different situations, ranging from the very stable to the purely chaotic, i.e., small differences may cause enormous consequences. These time series y_t are generated from Equation 2 for different values of k , assuming a given value of y_0 (e.g., beginning with 0.5, or any other value), depicting dramatically different behaviour patterns which depend on the precise value of k . (3) For example, a very stable situation is derived when $k = 1$, Figure 1b. The situation is less stable but still regular when $k = 2$, Figure 1c. "Wilder fluctuations" are observed for $k = 3.15$, Figure 1d, and "perfect" or "complete" chaos as $k = 4$, Figure 1e.

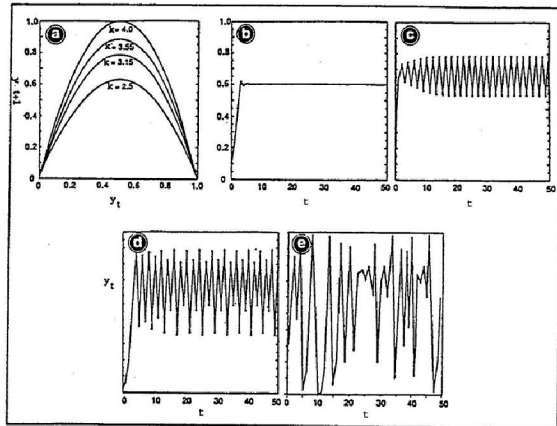


FIGURE 1

Logistic Graph

In other words, instability results when $k > 3$; the greater the value of k , the greater the instability. When $k = 4$, we speak of "chaos" and define (mathematically) "complete chaos" at the limiting value of $k = 4$. Manifestations of Equation 2 can be observed in nature, technology, and the economy, in the form of S-shaped or sigmoid curves as depicted in Figure 2. (1; 2; 7; 9).

B. Logistic Evolution

In nature one can observe mutations. As a consequence, new types with higher k -coefficients sometimes emerge in a population and replace older ones. Similar processes also occur in the economy, but we prefer to speak of these in terms of inventions

and innovations instead of mutations. The fundamental idea, however, is the same. The k -value of some production processes may increase.

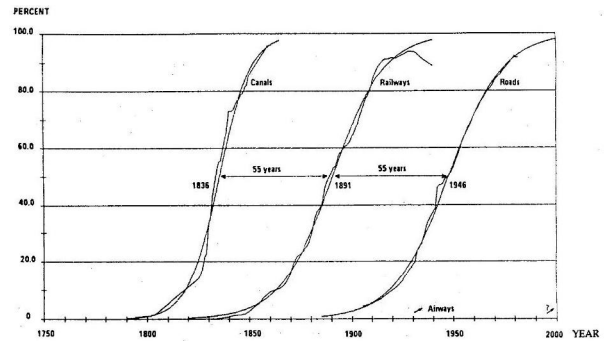


FIGURE 2
Growth of Infrastructure in the U.S.A.
(Percent saturation length)

C. Instability

Because of this rise in the k -value, our destiny changes without us immediately being aware of it. For $k > 3.2$ we observe instability in the former stable sigmoid curves and these fluctuations intensify with increasing values of k . (As shown above, for $k = 3.15$ regular fluctuations are observable, Figure 1c, but higher values of k lead to less "regularity" and increased instability.) When $k = 4$, there is complete "chaos," as previously defined. Instability is dangerous, because competitors might exploit the situation and conquer the market; the larger the k -value the greater the danger, as shown in Figure 1.

In reality we might not always see this instability. Sometimes the situation might look very stable, even though k is rather high. For example, a stream of new inventions and innovations could enable newcomers to grow, whereas older firms in the industry might suffer a setback. In this scenario, streams of new inventions and innovations may produce stable growth patterns for an industry as a whole.

2. Vitality

We can say that a population is viable if it has high vitality. This vitality depends on the degree of growth, the level of maximum production or carrying capacity, the degree of competition, the number of mutations, the resistance to disadvantageous conditions, and stability. The concept of viability can also be applied to various forms of production or industries, though it is difficult to take full account of the many aspects involved, because of their different dimensions.

It is a problem of comparing like with unlike. We can overcome this problem by using index numbers, and weighting each of the aspects in accordance with their “importance” to viability.

The vitality of a population or of a production process (industry) depends on aspects such as size and stability. We know that both, size (quantity) and stability, depend on the value of k (are functions of k), but also that they cannot be added directly. This can be resolved by using an index number of vitality, such as:

$$N_0 = w * quantity + (1 - w) * stability \quad (3)$$

where w is defined as the number of competitors.

Stability is especially important if k is high and there are no mutations (or inventions and innovations). This becomes increasingly important as the number of competitors, w , increases. We can combine all these aspects in the Newell index (6):

$$N = \frac{hw(k-1)(2.6-k) + (1-hw) \log k}{k} \quad (4)$$

$\log k$ reflects the growth of the population (or of production).

The resistance to deteriorating conditions is equal to the b -coefficient in Equation 1; it is a function of $1/k$ and, therefore, k is the denominator. Stability is indicated by $(k-1)(2.6-k)$. If k has a value between 1 and 2.6, the population (or production process) is very stable.

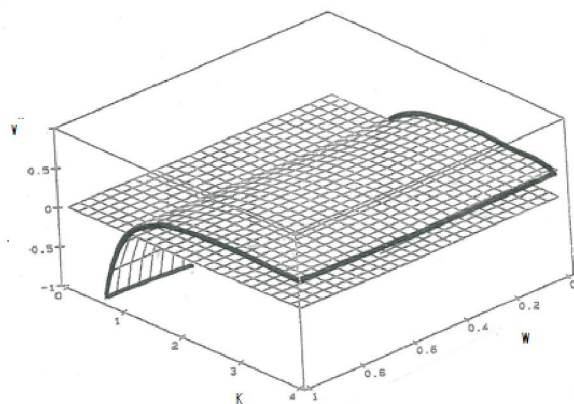


FIGURE 3

Newell Index for $h = 0$

However, this is not the case for other values of k . There are two values for h , e.g., $h = 1$ if there are no inventions and innovations. For $h = 0$, indicative of an abundance of inventions and innovations, the resulting Newell index is exhibited in Figure 3.

The rising curve in Figure 3 depicts a picture of the traditional idea of evolution. We have climbed this mountain of evolution. Many now believe we have ascended enough; we should stop now and stay put. We no longer need ever-increasing growth curves or accelerating inventions and innovations. In other words, we should accept zero growth. But opting for zero growth and/or zero innovation would have a most unexpected and undesirable effect.

If $h = 1$ the situation is not stable for high values of k and becomes more unstable as the number of competitors (w) increases.

As Figure 4 shows, the “mountain” of Figure 3 caves in, when $h = 1$ (no inventions or innovations). Only for w -values smaller than 0.2 are positive values of N still observed. That is the case if there are almost no competitors who will try to take advantage of the situation.

In nature we will sometimes find such a situation in what we call “living fossils”. For example, the stromatolites in Australia did not change over the last 500 million years because of lack of competition.

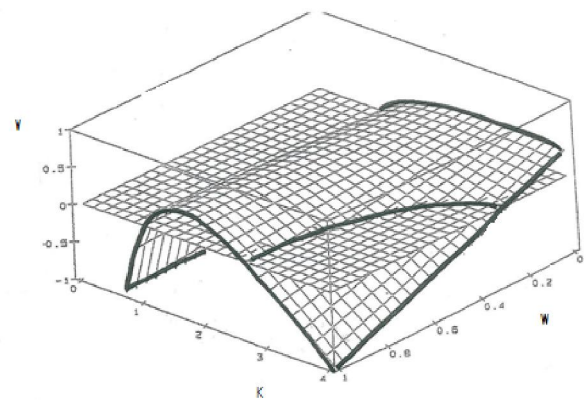


FIGURE 4

Newell Index for $h = 1$

We call them Methuselahs; Ward (10) described such creatures - they are rather rare.

Lack of inventions and innovations will lead to instability and this may prove to be fatal for the population. As indicated above, this can be observed by setting $h = 1$ in Figure 4; the mountain caves in

because part of the index N falls below zero. This, in essence, is representative of the extinction of that mode of production. Only those modes of production which experience low k values survive; the others become extinct like dinosaurs. There is one exception: for low w -values (no competition), Figure 4 shows that some high k -value populations may survive. This explains why companies attempt to corner the entire market (no competitors) or try to innovate all the time. Innovation is very important; without a stream of inventions and innovations the economy caves in. This can be illustrated with statistical data from Schumpeter, Grübler, Silverberg and Van Duyn, (6). See also Figure 5 below.

3. Competition

Competition plays an important role in the vitality of industries. There are various types of competition. Some are already operating in the phase of “ideas” or in the planning phase, others emerge once there are real products or technologies. Rivalry between innovations will develop and one will usually win out but will then face competition from other products and services. Various battles may influence the rate of growth. We may even expect evolutionary changes.

From the studies of Kuhn (4) and Mulkey (5) we know that the acceptance of new ideas is a complicated process in which “revolutions” in the power structure of the scientific community play an important role. Hence, we not only have to deal with “stoppages” in the process, but also with “goes”, both depending on the psychological and social factors that govern the acceptance of new ideas in science, industry and government. These revolutions may play an important role in the explanation of the Kondratieff or “long wave” cycles of economic expansions and contractions. They tend to have a wave length of between 40 to 60 years, which can be observed for the U.S. and Europe from 1750 on. Kondratieff cycles can be defined for the periods of 1782-1845, 1845-1891, 1892-1948 and from 1948-1993 (the latter is highly speculative). One must also expect some periods of conservative policies (what Kuhn calls “normal science”) which may ultimately result in $h = 1$, causing the whole process to grind to a halt.

The actual and predicted rates of innovation in the U.S. from 1800 to the year 2050 is depicted in Figure 5. (2) It can be observed that this rate is not constant. There are clearly high and low periods corresponding to the long waves of Kondratieff cycles in the economy (i.e., long-term business cycles of between 40-60 years duration). In other words,

interruptions in the innovation process have dramatic effects on the economy. One can imagine what might happen if the processes of invention and innovation came to a halt. Some people might think that this is not a real option, but, unfortunately, it still is an important factor in some political theorizing.

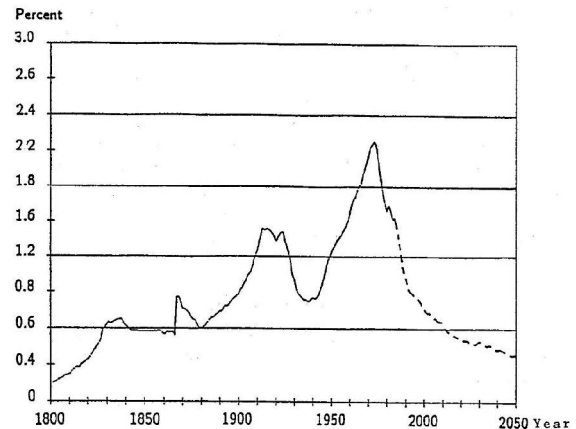


FIGURE 5
Rate of Innovation in the U.S.

The process of progress also has disadvantages. First, there are victims of revolutions and of competition. Second, systems will tend to become potentially more unstable. This may result in more cartel policies, more agricultural price policies, more social safety measures, and even more subsidies to industries. All of these can only be paid for if the system continues to function. If it comes to a halt, many of these social niceties fade away because national income decreases. Massive direct subsidies may even result in industries disappearing. For example, if the value of k were to increase from 2.6 to 3.4 (with a gift or subsidy), without inventions, innovations, or structural change ($h = 1$), total disaster would result - see Figure 4. These theoretical considerations are in accordance with the experiences of declining industries, such as shipbuilding, mining, textiles and steel in the Netherlands and other West European countries. (8)

4. Conclusion

Those who innocently advocate zero growth or zero inventions and innovations tend to overlook the importance of instability. If we want sustainability, we must, of course, prevent potential disasters as indicated in Figure 4, and, therefore, must try to ensure an unending stream of inventions and innovations. If there is no such stream, the most developed part of the economy will collapse, with disastrous consequences for society as a whole. Thus,

growth and innovation do not run counter to sustainability. To the contrary, without growth and innovation there will be no sustainability. Even the absence of inventions and innovations for short periods of time would have negative consequences (depressions). Hence, sustainability would be impossible to be achieved if society were to adapt zero growth or zero innovation policies.

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