

Proposed Experimental Test of Neutrino Sea as a Subquantic Medium (*).

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Summary. — Astrophysical findings coupled with known properties of a generalized neutrino-antineutrino flux suggest that there exists a finite medium which may be capable of transmitting electromagnetic radiation. Recent theoretical studies support this hypothesis. Previous studies of «ether drift» centered attention on Earth's orbital motion (30 km/s), largely ignoring galactic velocity (220 km/s). We suggest a critical experimental test using high-velocity emitters with flows parallel to the Earth's galactic motion.

On the basis of astrophysical data, WEINBERG ⁽¹⁾ concluded that there exists a generalized neutrino-antineutrino flux, the particles of which have a continuum of velocities from near zero to near c . The sources of this «neutrino sea» are the rather randomly distributed stars and galaxies. CHIU ⁽²⁾ suggested that this flux consists of 10^{11} neutrinos/cm²·s.

The author postulated this flux to be an isotropic, particulate medium capable of transmitting energy, assuming the existence of generalized electric and/or magnetic fields ⁽³⁾. Expanding these hypotheses the writer has postulated this flux to be the medium by which perturbations of these inter- and intra-galactic fields are propagated through space. The flux so defined may account

(*) To speed up publication, the author of this paper has agreed to not receive the proofs for correction.

(1) S. WEINBERG: *Phys. Rev.*, **128**, 1457 (1962).

(2) H. Y. CHIU: *Bull. Amer. Phys. Soc.*, **7**, 33 (1962).

(3) H. C. DUDLEY: *Bull. Amer. Phys. Soc.*, **7**, 568, 609 (1962); **8**, 599 (1963).

for the apparent duality of particles, as well as being the noninert substrate in which all particle interactions take place ⁽⁴⁾.

BOHM and VIGIER ⁽⁵⁾ introduced «hidden variables» and DE BROGLIE ⁽⁶⁾ proposed a «subquantum medium» in causal treatment of nonlinear quantum mechanics. He described the exchange of energy between this medium and an electron as fluctuations about a single quantized state of the electron; with A = action, ν = cyclic frequency, h , k = Planck's and Boltzman's constants and S = entropy we have,

$$h\nu = KT \frac{A}{h} = \frac{S}{K}.$$

DE SILVA and LOCHAK ⁽⁷⁾ concluded that an ether so defined is isotropic and cannot reveal absolute motion.

Much attention has been given recently to theoretical consideration of the interaction of electrons with neutrinos and antineutrinos. ROYER ⁽⁸⁾ concludes that the effect of the neutrino sea on electromagnetism is too small to be observed. However, STOTHERS ⁽⁹⁾ as well as DESROSIERS and O'DONNELL ⁽¹⁰⁾ conclude that the weak interaction ($\bar{\nu}_e$, $\bar{\nu}_e$) may be of significance in astrophysical energy exchanges.

In an original approach, BANDYOPADHYAY, CHAUDURI, and SAHA ⁽¹¹⁾ conclude that on the basis of the photon-neutrino weak-coupling theory, the neutrino sea may be the means of photon propagation.

1. – Experimental considerations.

In an analysis of the many series of experimental studies designed to establish the presence or absence of a medium for the transmission of electromagnetic radiation, most are shown to have centered their attention on the Earth's orbital motion about the Sun (30 km/s), presuming the ether, if present, would flow over the Earth's surface. The exception to this general rule was MILLER ⁽¹²⁾,

⁽⁴⁾ H. C. DUDLEY: *Bull. Amer. Phys. Soc.*, **9**, 738 (1964); **14**, 88 (1969); **15**, 93 (1970).

⁽⁵⁾ D. BOHM and J. P. VIGIER: *Phys. Rev.*, **85**, 146, 189 (1952); **86**, 208 (1954).

⁽⁶⁾ L. DE BROGLIE: *Nonlinear Quantum Mechanics* (English translation) (New York, 1960).

⁽⁷⁾ J. A. DE SILVA and G. LOCHAK: *Quanta* (English translation) (New York, 1969).

⁽⁸⁾ J. ROYER: *Phys. Rev.*, **174**, 1719 (1968).

⁽⁹⁾ R. B. STOTHERS: *Phys. Rev. Lett.*, **24**, 538 (1970).

⁽¹⁰⁾ L. DESROSIERS and P. J. O'DONNELL: *Phys. Rev. D*, **2**, 403 (1970).

⁽¹¹⁾ P. R. BANDYOPADHYAY, P. A. CHAUDURI and S. K. SAHA: *Phys. Rev. D*, **1**, 377 (1970).

⁽¹²⁾ D. C. MILLER: *Nature*, **133**, 162 (1934).

who by a sophisticated method of multiple reflections extending over a rather large plane, obtained results which he judged indicate that the Earth has a component of motion, at a velocity of 208 km/s, in a direction parallel to what is now considered to be the galactic plane. The criticism (1955) of Miller's calculations and conclusions ⁽¹³⁾ notwithstanding, it appears that his predictions of 1934 are supported by presently accepted observations (Earth's galactic velocity 220 km/s).

TOWNES *et al.* ⁽¹⁴⁾ developed a method of detecting possible «ether drift» which has an inherent accuracy of three orders of magnitude greater than most interferometer techniques. This consisted of using flowing NH_3 masers ($2.4 \cdot 10^{10}$ Hz), measuring the beats of two of these units aligned such that the long axes of the opposing units were maintained in an E-W line, seeking ether drift due to the Earth's motion about the Sun. No ether drift was observed. Orientation of the masers only along an E-W line would ensure that no ether drift along a near N-S line would be detected.

JASEJA *et al.* ⁽¹⁵⁾ have studied the beats of two intersecting He-Ne laser beams, oriented at 90° , in a horizontal plane (42.4° N lat.) (radiation $2.6 \cdot 10^{14}$ Hz). One arm was positioned in an E-W line. On rotation through 90° there was observed a rather constant (mean 275 kHz) frequency difference in the radiation transmitted by the two arms of the interferometer. These investigators suggested that this may be due to an effective optical path difference (EPD) resulting from magnetostriction of the mirror mountings. No effort was made to isolate the apparatus from the Earth's magnetic field.

It may also be assumed that the above frequency shift ($d\nu$) represents an EPD due to motion of (or within) a medium. Then $d\nu$ is a measure of the velocity V of the medium with respect to the interferometer:

since $d\nu$ is proportional to V^2/c^2 ,

assume $2(d\nu)/\nu = V^2/c^2$, $2(275 \cdot 10^3/2.6 \cdot 10^{14}) = V^2/c^2$,

then $V = 14$ km/s apparent velocity of medium in laboratory frame.

Because of the angle of flow of the neutrino sea *through* the Earth at 42.4° N lat., this apparent velocity is postulated to be a resultant, generating but a small fraction of the total EPD which may be produced if one arm of the

⁽¹³⁾ R. S. SHANKLAND, S. W. McCUSKEY, F. C. LEONE and G. KUERTI: *Rev. Mod. Phys.*, **27**, 167 (1955).

⁽¹⁴⁾ J. P. CEDARHOLM, G. F. BLAND, B. L. HAVENS and C. H. TOWNES: *Phys. Rev. Lett.*, **1**, 342 (1958); *Nature*, **104**, 1350 (1959).

⁽¹⁵⁾ T. S. JASEJA, A. JAVAN and C. H. TOWNES: *Phys. Rev. Lett.*, **10**, 165 (1963); *Phys. Rev.*, **133**, A 1221 (1964).

interferometer is maintained parallel to the Earth's galactic motion, with the second arm at 90° thereto.

For the purpose of detecting the presence of a medium, a system which depends on V/c , and which determines the influence of emitter velocities on frequency, appears superior to most interferometer systems. The Michelson-type interferometer depends on $(V/c)^2$ and is very sensitive to purely structural stresses which may alter the geometrical path of the beams.

It is proposed that the spectra generated by high-velocity emitters be studied, determining the effect of motion of the emitters parallel to the Earth's galactic motion. Thus it will be determined whether this motion will produce a difference in the observed frequencies.

Two experimental approaches are suggested, due to their inherent sensitivity: *a*) flowing gas masers or lasers operating in the microwave or far infrared range (after TOWNES⁽¹⁴⁾), and *b*) canal ray emission (visible range) in which the emitters are accelerated by a high potential (after IVES and STILWELL⁽¹⁶⁾). In both cases, matched units having opposite directions of emitter flow are to be aligned such that the flow axis is maintained parallel to the Earth's galactic motion. The initial orientation of the flow axis will be N-S, at an angle with the horizontal plane equal to the latitude of the point of observation. Further angular adjustments will vary with time of day and year. This assumes that the orbital plane is perpendicular to the galactic plane.

2. - Conclusion.

Incorporation of the neutrino hypothesis into theories of electromagnetic wave propagation began shortly after PAULI proposed what has become known as the neutrino. DE BROGLIE⁽¹⁷⁾ suggested a photon to be composed of a neutrino and an antineutrino. JORDAN⁽¹⁸⁾ proposed that the way in which neutrinos react with other particles leads to a simplified description of light. More recent approaches include that of PERKINS⁽¹⁹⁾, who proposes a four-component theory in which the basic particle is composed of two neutrinos and two antineutrinos.

BANDYOPADHYAY and CHAUDURI⁽²⁰⁾ assume a weak coupling of a neutrino and a photon as necessary for the propagation of electromagnetic radiation.

The writer has suggested that the neutrino family provides the basic units

⁽¹⁶⁾ H. E. IVES and G. R. STILWELL: *Journ. Opt. Soc. Amer.*, **28**, 15 (1938).

⁽¹⁷⁾ L. DE BROGLIE: *Compt. Rend.*, **195**, 536, 862 (1932).

⁽¹⁸⁾ P. JORDAN: *Ann. der Phys.*, **93**, 464 (1935).

⁽¹⁹⁾ W. A. PERKINS: *Phys. Rev.*, **137**, B 1291 (1965).

⁽²⁰⁾ P. BANDYOPADHYAY and P. R. CHAUDURI: *Nuovo Cimento*, **38**, 1912 (1965); **66 A**, 238 (1969); and (1971) in press.

by which perturbations of inter- and intra-galactic electric and/or magnetic fields are propagated.

An important aspect of each of the mechanisms outlined above is that the propagation of light is independent of the presence of a finite medium. From this it follows necessarily that the basic assumption of each theory is that there exists no «free space», and that the transmission of light is a resultant of a series of events, each time-dependent. Therefore the velocity of light is not an independent «universal constant» but is dependent on the nature of the transmitting medium and mechanism.

Should experimental studies as outlined above indicate a medium which influences the transmission of electromagnetic radiation, the results may *a*) aid in defining the «subquantic medium» of de Broglie, *b*) provide further experimental elucidation of the mechanism by which photons, neutrinos and other particles interact.

● RIASSUNTO (*)

Le recenti scoperte astrofisiche accoppiate con le note proprietà di un flusso di neutrini ed antineutrini generalizzato suggeriscono che possa esistere un mezzo finito capace di trasmettere la radiazione elettromagnetica. Recenti studi teorici suffragano questa ipotesi. Gli studi precedenti sul «trascinamento dell'etere» centrarono l'attenzione sul moto orbitale della Terra (30 km/s) trascurando in gran parte la velocità galattica (220 km/s). Si suggerisce una prova sperimentale critica per mezzo di emittenti di alta velocità con flussi paralleli al moto galattico della Terra.

(*) *Traduzione a cura della Redazione.*

Предлагаемая экспериментальная проверка моря нейтрино, как среды, представляющей субформу.

Резюме (*). — Астрофизические данные вместе с известными свойствами обобщенного нейтрино-антинейтринного потока предполагают, что существует конечная среда, которая способна быть источником электромагнитного излучения. Недавние теоретические исследования подтверждают эту гипотезу. Предварительно исследованный «дрейф эфира» сосредоточил внимание на орбитальном движении Земли (30 км/сек), в основном, игнорируя галактическую скорость (220 км/сек). Мы предлагаем критическую экспериментальную проверку, используя излучатели, движущиеся с большой скоростью, с потоками, параллельными галактическому движению Земли.

(*) *Переведено редакцией.*