

LETTERS TO THE EDITOR

A NEW THEORY OF QUASARS

BY S. M. W. AHMAD*

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It is now well known that quasars are enormous source of energy. The problem of accounting for the enormous energy from quasars is still far from solved. Theories presented so far fail to fit in with the data collected and analysed by the Astronomers (during the recent years). Theories of gravitational collapse and annihilation of matter and antimatter have their own draw-backs.

The energy problem is common to radio galaxies and quasars. Where does a total energy of more than 10^{60} ergs in an individual radio galaxy or quasar come from? How is the energy transformed to relativistic particles for the production of light and radio waves? Answers to these questions have (during recent years) appeared in scientific journals. But so far there is no unified solution.

The radio spectrum of the quasars (and the observation that radio waves are polarised) indicate that the radio waves are emitted by the same process as occurs in the High Energy Machines, and known as the synochrotron process.

Recently a theory based on the spontaneous transformation of pi-mesons into photons was proposed by the author [1]. According to this theory the huge energy release is accounted for on the basis of the ratio of time (few weeks/ 4×10^{-16} sec) involved in the fusion reaction (in the stars) and the transformation of pi-mesons into photon.

In this letter I wish to propose another possible solution of the energy problem. Let us accept the quark model [2] in which all the known elementary particles are constructed from quarks and anti-quarks. So far quarks have not been discovered, and it is not essential for SU (3) scheme [3] that quarks themselves should actually exist as separate physical particles (they may be only mathematical objects). In the theory proposed in this letter, we shall, however, assume that quarks are real physical particles and that they are so massive that even biggest accelerators so far available have insufficient energy to produce them. It is a little hard to understand why the quarks have not been observed in cosmic rays; it may be that the quarks are so massive that their production by cosmic radiation as well is a rare phenomena.

* Address: P-Block, North Nazimabad. A/81, H. D'Silva Town, Karachi-33, Pakistan.

Now if the protons and neutrons are constructed from quarks it is obvious that the almost entire mass of the quarks (which are much heavier than the protons or neutrons) has been transformed into the binding energy. The process is similar to the binding energy (and the mass defect) in the case of the nuclei of atoms.

We now assume that quasars consists mostly of neutrons and protons (the density and the pressure are very high), and that the physical conditions (in the interior of the quasars) are such that the protons (and the neutrons) can break up into quarks. The energy (it could be millions of times greater than the energy from our Sun depending upon the number of nucleons available for break-up into quarks, the mass of quarks and other factors) released in the split up of nucleons into quarks must be very much greater than the energy emission due to the fission of the nuclei (the efficiency of the nuclear fission is very poor).

The energy required to initiate the split-up of nucleons into quarks need not be very powerful. In the case of the nuclear fission slow neutrons (and not very energetic ones) initiate the process which is self-sustaining). In the case of quasars, it is possible that due to the huge gravitational pressure the nucleons break-up into the constituents (the quarks). This is only one of the many possibilities in which the above split up can occur.

Before concluding, I may point out that so far only two processes have been known whereby Nature can release energy from matter:

(i) the inter-atomic — the burning of coal, oil *etc.*

(ii) the sub-atomic — the fission of the nucleus and the fusion re-action.

The (i) was discovered much earlier than that the (ii). The above theory suggests a third process in Nature: The break-up of the nucleons into the quarks (which may exist). It appears that man is digging deeper and deeper into the atoms. The above quark theory also fits into the historical order of things.

REFERENCES

- [1] S. M. W. Ahmad, *Nuovo Cimento*, **17**, (1965).
- [2] M. Gell-Mann, *Phys. Letters*, **8**, 214 (1964), G. Zweig, CERN Report TH-401 nad TH-412 (1964) unpublished.
- [3] See, for example, M. Gell-Mann und Y. Neeman, *The Eight Fold Way*, Benjamin, Inc. 1964.