Pramāṇa, Vol. 26, No. 6, June 1986, p. 561. © Printed in India.

Remarks on binding energy of fermions in Newtonian gravity

C SIVARAM
Indian Institute of Astrophysics, Bangalore 560034, India

MS received 13 September 1985

Abstract. The clarifications made regarding the binding energy in connection with a model for the internal structure of black holes are shown to be incorrect.

Keywords. Black holes; planckions; binding energy.

PACS No. 97·60; 95·30

In a recent paper, Goswami and Sinha (1985) have sought to clarify some aspects of their model for the so called internal structure of black holes, wherein a black hole is pictured to be an assembly of planckions (of Planck mass, $M_p \sim (\hbar c/4G_N)^{1/2}$) considered to be fermions.

For two planckions interacting gravitationally at the separation of a Planck length, the rest mass energy can be cancelled by the gravitational binding energy. However the authors go on to make the claim that this is true for an arbitrary number of planckions (which are supposed to constitute the black hole, packed at the planck number density $\sim (c^3/\hbar G_N)^{3/2}$.) Thus the enormous mass in planckions ($\sim 10^{109}$ g for a solar mass black hole) is supposed cancelled by their gravitational binding energy. That such a cancellation is impossible for an arbitrary number N of planckions is easily seen by noting that the Newtonian gravitational binding energy is $\sim GN^2M_p^2/R$ (Note dependence on N^2) and if the average separation between planckions is the Planck length L_p (which the model requires) then $R \sim N^{1/3} L_p$, so that the gravitational binding energy goes as $N^{5/3} \times (GM_p^2/L_p) \approx N^{5/3} M_p c^2$, whereas the total rest mass energy rises only *linearly* as NM_pc^2 so for large N they would be very different. Thus there is no possibility of the rest mass energy being consumed by the gravitational binding energy.

Again consider equation (5) for the gravitational pressure which they assume is obtained by the gravitational interaction of the black hole mass M_B with its bare (nucleonic) mass M_N as: $P_G \approx (M_B/R_0)\cdot(M_N/V_B)$. Now what should enter into the expression for the gravitational pressure force is the *net* mass and not the *bare* mass. So if they claim that the nucleonic bare mass i.e. (M_N) is somehow cancelled by its gravitational binding energy then the *net nucleonic mass* M_N is *zero*, so that P_G is zero! Again what contributes to P_G is not only the gravitational interaction between M_B and M_N but also their own self-energies which are proportional to GM_N^2 and GM_B^2. If M_N is to be chosen to have its bare value, (i.e. $M_N \gg M_B$) then the dominant term in the expression for P_G would be the GM_N^2 term and not the much smaller $GM_N M_B$ term which the authors have used.

References

Goswami P and Sinha K P 1985 *Pramana (J. Phys.)* **25** 223