

## Remarks on binding energy of fermions in Newtonian gravity

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**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.

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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  $NM_p c^2$  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