Extragalactic Astrophysics: Question Sheet 1

1. **GRBs** A typical bright gamma-ray burst fluence (time-integrated flux) is $\sim 10^{-4}$ erg/cm^{-2}, with the photons all arriving within about 10 seconds. Assume a distance of 4000 Mpc (1 pc $= 3 \times 10^{18}$ cm). Also assume that all photons are about 1 MeV at the source. Ignore cosmology, redshifts, general relativity, and other such details.

(i) Calculate the approximate energy of the burst.

(ii) Compute the gravitational binding energy of a neutron star. Assume that a neutron star is a uniform sphere of mass $M = 1M_{\odot}$ and a radius $R = 10$ km. Compare the energy of the GRB with the binding energy of the neutron star.

(iii) If one assumes that if the burst takes place in 10 s, the size of the emitting region must be less than or approximately equal to 10 s times the speed of light. Using this maximum radius, calculate the energy density and the number density of photons.

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