THE ORIGIN OF THE ENHANCED DISSIPATION "α" IN ACCRETION DISCS AND ITS RELATION TO GAMMA BURSTS

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ABSTRACT. The source of the enhanced dissipation or "α" viscosity of Keplerian accretion discs is central in all putative mechanisms for large energy release by matter accreting onto condensed objects and for the basic mechanism of star formation. The circumstances of gamma burst formation on neutron stars suggest convective buoyancy as a necessary condition for the large α. This is because the total mass $\cong 10^{19}$ g necessary to supply the energy of a gamma burst derived from infall is a natural limit for the mass stored in a disc without α viscosity. This suggests that buoyancy driven convective turbulence is the source of the enhanced transport in disc evolution models (Shakura and Sunyaev 1973). In support of this conjecture we find that the maximum possible energy released by ideal friction operating on the velocity shear of a disc is twice that required to destabilize the angular momentum distribution of such a disc. The heat energy available from an α viscosity is twice that necessary to create α in the first place. Hence, a nonlinear instability--nonlinear to create convective turbulence and nonlinear to create shear viscosity heating--is sufficient to drive α. One characteristic that would prevent the formation of such an instability is degeneracy of the disc matter as it accumulates near a neutron star (Paczynski and Jaroszynski 1978). Degeneracy inhibits strong convection because a given energy release within degenerate matter results in a large temperature, and hence large energy transport without convection. Convection occurs in an accretion disc whenever the energy which is dissipated in the disc requires a superadiabatic temperature gradient for its radiative or conductive transport to the surface. Some gamma burst mechanisms require exactly such a mechanism as a degenerate disc close to the neutron star in the correct mass ($\cong 10^{19}$ g), at the correct radius several times the neutron star radius, to supply gravitational energy for a gamma burst. The degenerate disc accumulates mass stably until the density is great enough that degenerate fluid viscosity evolves the disc into contact with the neutron star. The large energy released by velocity shear at contact heats the disc causing rapid evolution and a gamma burst.

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