IRON CORE COLLAPSE IN 10 TO 30 $M_\odot$ STARS AND THE EFFECT OF μ NEUTRINOS

(Abstract)

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The evolution of 10, 20, 30 $M_\odot$ stars were calculated by Barkat, Rakavy and Reiss up to the point of Fe core collapse. The calculations produced Fe cores of masses 1.49, 1.6 and 2.2 $M_\odot$. The core collapse and the subsequent envelope burning were studied with the Wilson (1971) hydrodynamic neutrino transport computer programme. The results are that the high mass (2.2 $M_\odot$) core bounced with a weak outward shock that did not push back the envelope at all. The low mass core (1.49 $M_\odot$) bounced and sent a fairly strong shock out into the envelope. However, the shock was not strong enough to detonate the envelope. The envelope in this case was also at too low a density to support detonation by itself. The calculations produced no supernova. Lower mass Fe cores are indicated for the production of stronger outward shocks. Shock weakening with increasing core mass is due to neutrino cooling in the shock.

S. Weinberg has suggested that μ-neutrinos may act like electron neutrinos. In the iron core collapse calculations of Wilson (1971), 70 to 90% of the collapse energy was released by μ neutrinos. One therefore might expect large effects by changes of μ neutrino interactions. Two models (1.5 $M_\odot$, 3 $M_\odot$) were calculated with the μ neutrinos treated the same as the electron neutrinos (same opacity). The behaviour was very similar to the standard treatment except that the late cooling was much slower. However, by this time the system had become quiescent. The Weinberg hypothesis was also applied to the burning of a collapsing cold carbon white dwarf model of Craig Wheeler. With the regular μ neutrino model, the fraction of carbon needed to avoid disruptive explosion was less than or equal to 20%. Treating the μ neutrinos like electron neutrinos raised the limit on carbon for the formation of a neutron star to 70%. Changes in the electron neutrino opacity of the order of 10 in the standard treatment produced a smaller effect in the critical carbon composition.

Reference

Wilson, J. R.: 1971, *Astrophys. J.* **163**, 209.

Tayler (ed.), Late Stages of Stellar Evolution, 153.