IC/73/133

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

TOPICAL SEMINAR

ON

WEAK INTERACTIONS

26 - 29 June 1973

(SUMMARIES)

INTERNATIONAL ATOMIC ENERGY AGENCY

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

1973 MIRAMARE-TRIESTE

IC/73/133

International Atomic Energy Agency
and
United Nations Educational Scientific and Cultural Organization

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

TOPICAL SEMINAR
ON
WEAK INTERACTIONS

26 - 29 June 1973

(SUMMARIES)

MIRAMARE - TRIESTE
July 1973

Please note that copies of papers referred to may be obtained direct from the authors and not from the ICTP.

NEUTRINOS FROM COLLAPSING STARS

S.A. Bludman

University of Pennsylvania, Philadelphia, Pa., USA.

A new model for collapsing stars is presented, based on the collapse of a white dwarf core to a very hot neutron star followed by neutrino energy transport to the thin opaque shell of the neutron star which is blown off by neutrino deposition. The model produces supernova nebula blow-off and predicts accompanying neutrino pulses of about $10^{11}/cm^2$ at Earth about 0.04-0.17 times per year.

Based on the Salpeter initial distribution of stellar masses in our galaxy, about 0.8 stars die per year. Of these dying stars, approximately 20% will be advanced red giants lying in the 3.5-10 $M_\odot$ mass interval from which pulsars and supernova are believed to originate. According to present theories of advanced stages of evolution, stars throughout this mass interval develop a unique carbon-oxygen white dwarf core whose ultimate fate depends delicately on a competition between neutrino cooling and C^{12} ignition.

In at least one-fourth of all such dying red giants (0.03 collapses per year), the 1.4 $M_\odot$ white dwarf core collapses to a 1.25 $M_\odot$ hot neutron star releasing 3×10^{53} ergs of gravitational binding energy. Neutronization of the C and O during collapse releases at least 0.4×10^{57} neutrinos in 0.1 seconds, carrying off about 10^{52} ergs. Possibly another 10^{53} ergs is radiated gravitationally or stored in pulsations. The remaining 2×10^{53} ergs, or 70 MeV/baryon, heats the neutron star to 10^{12}K.

In the degenerate core of the hot neutron star, $\nu + \bar{\nu}$ are emitted by ν-bremsstrahlung at 5×10^{86} erg/sec. Because the neutron star has a 0.015 $M_\odot$ envelope in which $\nu + N \rightarrow e^- + P$ (and less so $\bar{\nu} + P \rightarrow e^+ + N$), this 1 km thick neutron star envelope is blown off while converting energetic ν into 10 MeV protons. The $\lesssim 10^{53}$ ergs converted into protons more than suffices to then blow off the red giant envelope at initial velocities exceeding 20,000 km/sec and to produce the 10^{51} ergs optical supernova display. The remaining $\gtrsim 10^{53}$ ergs if consisting of 10 MeV neutrinos (the majority of which will be $\bar{\nu}$ rather than ν) will, at 15 kpc distance, produce a short pulse of 10^{11} neutrinos/cm^2.