



OMNIS, The Observatory for Multiflavour Neutrinos from Supernovae

A. St J. Murphy^a and R. N. Boyd^b for the OMNIS collaboration

^aDepartment of Physics, The University of Edinburgh, Edinburgh, EH9 3JZ, SCOTLAND

^bDepartment of Physics, Department of Astronomy, The Ohio State University, Ohio, 43210, USA

Collaborators in the US and in UK have been considering designs for a novel new facility that would be able to observe a large number of neutrinos arriving from the next galactic supernova. In particular, such a detector would aim to compliment the anti-electron neutrino sensitivity of existing neutrino detectors by providing a large signal from the electron-, muon- and tau-flavours of neutrino.

When a massive star undergoes core-collapse, some 99% of the energy released is in the form of neutrinos, initially ν_e s from the macroscopic neutronization of the core material, and then neutrinos of all flavours as neutrino emission dominates the cooling of the protoneutron star. The additional opportunities that electron and antielectron neutrinos have to interact via the charged current (CC) interaction result in their neutrinospheres extending farther, and in their energy spectra being of lower temperature. The numerical predominance of neutrons over protons further reduces the energy distribution of the electron neutrinos [1].

The detector would operate by observing the neutrons emitted following the interaction of the supernova neutrinos with large volumes of lead [2]. The combination of the energy threshold for neutron emission, together with the location of the energy levels through which neutron emission could proceed, means that this mechanism only selects high energy neutrinos from (a) NC interactions from all types of neutrino and (b) CC interactions from high energy electron neutrinos. The yield of neutrons from OMNIS is thus highly sensitive to the neutrino temperature distributions. Although the ν_e flux emitted at the

ν_e neutrinosphere is predicted to comprise only quite low energy neutrinos, high energy ν_e s are expected due to MSW transitions in the supernova envelope. The yield of events in which two-neutrons are emitted is even more sensitive to the high energy component of the neutrino temperature distributions. Hence the observation of the one- and two-neutron spallation fluxes provides information on the energy and arrival time profiles of the supernova neutrinos, resulting in a stringent diagnostic of the core collapse process. In addition, new information on the MSW or vacuum mixings (especially on the mixing matrix element U_{e3}^2), direct measurements of neutrino mass, and possibly direct observation of the formation of a black hole can be achieved [3].

Additionally, modules containing large volumes of lead perchlorate ($Pb(ClO_4)_2$) are being considered [4]. This is a transparent liquid when dissolved in water, and hence Čerenkov radiation following CC events can be observed. This would allow the ratio of CC/NC events to be determined directly and perhaps also allow a direct measurement of the ν_e energy distribution, which due to the MSW transitions will reflect the $\nu_{\mu/\tau}$ distribution as emitted from the cooling neutronstar.

REFERENCES

1. Y.Z. Qian *et al.* Phys. Rev. Lett. **71** (1993) 1965
2. J.J. Zach *et al.* Nucl. Instr. Meth. Phys. Res. A **484** (2002) 194
3. J. Beacom *et al.* Phys. Rev. Lett. **85** (2000) 3568
4. S. Elliot Phys. Rev. C **62** (2000) 065802