Resonant Spin-Flavor Conversion of Supernova Neutrinos

Shin'ichiro Ando[1] and Katsuhiko Sato[1,2]

[1]*Department of Physics, School of Science,*
The University of Tokyo, 7-3-1 Hongo,
Bunkyo-ku, Tokyo 113-0033, Japan

[2]*Research Center for the Early Universe,*
School of Science, The University of Tokyo,
7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

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Abstract

We investigate resonant spin-flavor (RSF) conversions of supernova neutrinos which are induced by the interaction of neutrino magnetic moment and supernova magnetic fields. From the formulation which includes all three-flavor neutrinos and anti-neutrinos, we give a new crossing diagram that includes not only ordinary MSW resonance but also magnetically-induced RSF effect. With the diagram, it is found that four conversions occur in supernova, two are induced by the RSF effect and two by the pure MSW. We also numerically calculate neutrino conversions in supernova matter, using neutrino mixing parameters inferred from recent experimental results and a realistic supernova progenitor model. The results indicate that until 0.5 seconds after core bounce, the RSF-induced $\bar{\nu}_e \leftrightarrow \nu_\tau$ transition occurs efficiently (adiabatic resonance), when $\mu_\nu \gtrsim 10^{-12}\mu_B(B_0/5\times10^9\mathrm{G})^{-1}$, where B_0 is the strength of the magnetic field at the surface of iron core. We also evaluate the energy spectrum as a function of $\mu_\nu B_0$ at the SuperKamiokande detector and the Sudbury Neutrino Observatory using the calculated conversion probabilities, and find that the spectral deformation might have possibility to provide useful information on neutrino magnetic moment as well as magnetic field strength in supernovae.[1]

[1] Reference: S. Ando and K. Sato, Phys. Rev. D **67**, 023004 (2003).