N09a Explosive Nucleosynthesis Associated with Formation of Jet-induced GRBs in Massive Stars

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We perform 2-dimensional relativistic hydrodynamical simulations in the context of collapsar model. Calculations of explosive nucleosynthesis are also accomplished. We investigate the influence of the structure of the progenitor and energy deposition rate on the resulting explosive nucleosynthesis. We show the amount of ^{56}Ni is very sensitive to the energy deposition rate. Thus we conclude that it is quite natural not to detect an underlying supernova in some X-ray afterglows as in GRB 010921. We also point out the possibility that the relative abundance of the elements with intermediate mass number such as Si and S in the X-ray afterglow of GRB 011211 may be naturally explained if the energy deposition rate at the central engine is relatively long because little amount of ^{56}Ni should be synthesized under such an environment. If this discussion is true, there should be correlation between the line features in the X-ray afterglow and duration of the GRB. It should be noted that the duration of GRB 011211 is 270 seconds, making it the longest burst ever observed by Beppo-SAX, which supports our conclusion. Our results also suggest that the type I collapsar model in which the energy deposition rate is relatively low ($\dot{E} \sim 10^{51}$ erg s^{-1}) may have difficulty in reproducing the observed amount of ^{56}Ni in a hypernova such as SN 1998bw. This means that the mechanism of the central engine of a hypernova accompanying GRB is constrained by the discussion of explosive nucleosynthesis.