# ORIGIN OF COSMIC RAYS, ATOMIC NUCLEI AND PULSARS IN EXPLOSIONS OF MASSIVE STARS

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**Abstract.** Explosions of massive stars ($8 \lesssim M/M_{\odot} \lesssim 70$) are examined as the source of galactic cosmic rays. Detailed nucleosynthetic and evolutionary calculations suggest that these massive stars produce the heavy elements (carbon and above) in their proper relative abundances. This is particularly significant because lower mass stars (in particular the 4–8 $M_{\odot}$ range) are not able to produce the observed abundances of C and O relative to the iron peak. A small ($\sim 1.4\, M_{\odot}$) dense remnant star (a neutron star) left after the explosion may provide a location for an electromagnetic acceleration mechanism. Those abundance ratios which can now be predicted (He, C, O, Ne, Mg) for the material to be accelerated by the pulsar give a reasonable match to the observed cosmic ray data. The conditions at the outer edge of the remnant and the inner edge of the ejected material may be appropriate for an **r**-process to occur; the high $Z$ cosmic rays seem to show an enrichment of **r**-process material. It appears that these stars may be the astrophysical source for the galactic cosmic rays. The questions of rotation and black hole formation were discussed. It appears that the most straight-forward result of evolution of a close massive binary is a massive star and a neutron star in a low eccentricity orbit, in agreement with observation.

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