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Exploring the Physics of Supernova Explosions

JOHN BLONDIN, North Carolina State University

There is a growing body of evidence that core-collapse supernova explosions are inherently asymmetric. The origin of this asymmetry may arise in the first few hundred milliseconds after core collapse, when the nascent shock wave is susceptible to the spherical accretion shock instability. As part of the Terascale Supernova Initiative, we are using large-scale three-dimensional simulations to investigate the role of hydrodynamic instabilities in core-collapse supernovae. We show that the collapse of a stationary, spherical star can, through the development of the SASI, produce an asymmetric explosion, leave behind a rapidly spinning neutron star, and impart a significant neutron star kick.