Core-Collapse Supernovae, Mergers & GRBs, r-Process

Nuclear Astrophysics Town Meeting
2012
Open Questions and Challenges

• What is the core-collapse supernova mechanism?
• What is the neutrino, gravitational and photon signature of CCSNe and GRBs?
• How are CCSNe and long GRBs related?
  What is the full range of outcomes of collapse?
• Are mergers making short GRBs?
• How do the mechanisms affect the nucleosynthesis in these events?
• r-process site???
Recent/Near Future Progress

• Spectral radiation-hydro models of CCSNe reveal neutrino-powered explosions, but much delayed compared to a decade ago.

• 2D full physics CCSN models there, soon 3D.

• Very clear observational connection between peculiar CCSNe and long GRBs.

• CCSN progenitor & shock breakout observations.

• Wide-field surveys reveal full range of supernovae.

• LIGO will tell us about mergers & GRB connection.

• Better v transport: no r-process (?) in CCSNe, but ν-p process. Mergers a possibility.
What is needed?

- Need full physics 3D CCSN, but also cheaper calibrated alternative for parameter studies.
- Neutrino oscillation physics must be understood and included as appropriate.
- Merger simulations must reach microphysics & ν sophistication of CCSN models.
- Inputs: EOS, neutrino microphysics, and multi-D stellar evolution.
- We need FRIB for r-process & electron capture data.
- Optimize/coordinate multi-messenger observations: photons, neutrinos, gravitational waves.