

Core-Collapse Supernovae: Models and Observable Signals

Week 1 (6/25-6/29)

Monday 6/25

3 pm - Opening remarks: Important Questions and Topics

Tuesday 6/26

10:30 am - Informal Presentation: Schuyler Van Dyk (30 min.), SN Progenitors

3 pm - Progenitor Discussion, Discussion Leaders: S. Van Dyk, J. Murphy

Wednesday 6/27

10:30 am - Informal Presentation: James Lattimer (30 min.), Equation of State

3 pm - EOS Discussion, Discussion leaders: J. Lattimer, M. Hempel, G. Shen, E. O'Connor

Thursday 6/28

10:30 am - Informal Presentation: Rodrigo Fernandez (30 min.), Hydrodynamic Instabilities in CCSNe

3 pm - Instabilities Discussion, Discussion leaders: R. Fernandez, J. Murphy, S. Couch

6pm - BBQ

Friday 6/29

10:30 am - Informal Presentation: Almudena Arcones (30 min.), Nucleosynthesis in CCSNe

3 pm - Nucleosynthesis Discussion, Discussion leaders: A. Arcones, R. Surman

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Week 2 (7/2-7/6)

All talks are in room C520. A total of one hour is allotted for each talk. The speaker has 30-45 minutes to present, and the rest is intended for discussion.

Monday 7/2

8:00 am - Registration in Room C411

9:00 am - Rodrigo Fernandez, Hydrodynamics of CCSNe at the Transition to Explosion

Abstract: In spherical symmetry, the onset of core-collapse supernova explosions involves a global instability of the shocked flow which operates on the thermal time. If spherical modes play a relevant role in a multi-dimensional context, the observed reduction in the critical neutrino luminosity for explosion with dimensionality would arise from a change in the properties of the background flow in which these modes develop. I'll discuss the nature of these exploding modes in spherical symmetry, the insight that they provide on the processes controlling the explosion, and their extension to the multidimensional case.

10:00 am - Jim Lattimer, Symmetry Energy Parameters and How the EOS is Taking Shape

11:00 am - Coffee

11:30 am - Sanjay Reddy, Neutrino opacities in dense matter: An appraisal of past and recent calculations

12:30 pm - Lunch

3:00 pm - Arcones Almudena, Nucleosynthesis in Supernovae

4:00 pm - Tea Time (and Coffee)

4:30 pm - Schuyler Van Dyk, Direct Identification of Core-Collapse Supernova Progenitors

Abstract: Connecting the endpoints of massive star evolution with the various types of core-collapse supernovae (SNe) is ultimately the fundamental puzzle to be explored and solved. This is best accomplished through direct identification of the actual star that has exploded in pre-supernova imaging, preferably in more than one photometric band, where color and luminosity for the star can be precisely measured. We can then interpret the star's properties in light of expectations from the latest massive stellar evolutionary models, to attempt to assign an initial mass to the progenitor. We have done this for SNe II-P, II-L, II_n, and II_b; however, the progenitors of SNe Ib and Ic remain elusive.

Tuesday 7/3

9:00 am - Christian Cardall, Simulations of SASI, turbulence, and magnetic field amplification

Abstract: Results from magnetohydrodynamics (MHD) simulations of the SASI will be presented. We have studied the development of turbulence during the nonlinear phase of the SASI. The turbulence develops from shear flows induced by the spiral mode of the SASI. Our analysis suggest that the development of turbulence contributes to the nonlinear saturation

of the SASI. Moreover, magnetic fields are efficiently amplified by a SASI-driven small-scale dynamo. The talk will focus on the results presented in arxiv:1203.3385 and arxiv:1203.3748, and more recent results.

10:00 am - Achim Schwenk, Chiral effective field theory constraints for the equation of state and for supernova neutrino rates

11:00 am - Coffee

11:30 am - Evan O'Connor, NuLib: An open-source neutrino interaction library for computational simulations of high-energy astrophysical systems

12:30 pm - Lunch

3:00 pm - Rebecca Surman, The Rare Earth Peak: An Overlooked r-Process Diagnostic

4:00 pm - Tea Time (and Coffee)

4:30 pm - Thierry Foglizzo, An experimental approach to shock instability during core collapse
Abstract: SWASI is a shallow water analogue to a shock instability. It is the first experiment demonstrating the hydrodynamical processes responsible for SASI oscillations observed in some astrophysical simulations. It illustrates the potential consequences of SASI on the neutron star spin, on a scale which is a hundred times slower and a million times smaller than its astrophysical analogue.

Wednesday 7/4

9:00 am - Bernhard Mueller, Relativistic Core-Collapse Supernova Explosion Models

Abstract: We present several general relativistic explosion models of core-collapse supernova, which shed light on a number of important questions in supernova physics. In particular, we discuss the impact of general relativity on the heating conditions, the growth of hydrodynamical instabilities, and the gravitational wave signal.

10:00 am - Andrew Steiner, Nuclear Symmetry Energy, Neutron Star Radii and Core-Collapse Supernovae

Abstract: Recent neutron star mass and radius observations are providing important constraints on the equation of state of dense matter. Neutron star radii are most likely less than 13 km and thus many equations of state are ruled out, including some commonly employed in simulations of core-collapse supernovae. These same mass and radius observations are also constraining the nuclear symmetry energy and, in particular, constraining the derivative of the symmetry energy described by the parameter L . Current observations suggest that L is rather small, and we present preliminary results on new EOS tables for use in future simulations.

11:00 am - Coffee

11:30 am - Satoshi Nakamura, Nuclear and Neutrino Physics in Stellar Core Collapse

12:30 pm - Lunch

3:00 pm - Florian Hanke, Is strong SASI activity the key to successful neutrino-driven supernova explosions?

4:00 pm - Tea Time (and Coffee)

4:30 pm - Martin Obergaulinger, Amplification of magnetic fields in core collapse

Abstract: Various processes may lead to the amplification of magnetic fields in stellar core collapse. I will discuss some of the most important amplification mechanisms in rotating and non-rotating cores and the feedback of magnetic fields on the dynamics of the core.

5:30 pm - **Dinner at Ivar's Salmon House**

8:00 pm - **Walk to Gasworks Park to view fireworks**

Thursday 7/5

9:00 am - Jeremiah Murphy, Neutrino-driven Convection and Neutrino-driven Explosions

10:00 am - Constantinos Constantinou, The EOS of SN Matter

11:00 am - Coffee

11:30 am - Georg Raffelt, Linearized Stability Analysis for Collective Flavor Oscillations of Supernova Neutrinos

Abstract: The onset of collective flavor oscillations of SN neutrinos corresponds to a run-away solution of the nonlinear equations of motion. A linearized stability analysis suggests that during the early accretion phase of iron-core SNe the multi-angle matter effect suppresses collective flavor oscillations so that flavor conversions seem to occur only through the usual MSW effect.

12:30 pm - Lunch

3:00 pm - Baha Balantekin, Invariants of the Collective Neutrino Oscillations in Supernovae

4:00 pm - Tea Time (and Coffee)

4:30 pm - Joshua Dolence, TBA

Friday 7/6

9:00 am - Sean Couch, Multidimensional CCSN Simulations with FLASH

Abstract: I will discuss our recent efforts to simulate neutrino-driven core-collapse supernovae with FLASH in 1D, 2D, and 3D. Many aspects of the current version of FLASH that make it a good tool for investigating CCSNe, as I will describe. I will also mention our efforts to simulate magneto-rotational CCSNe including neutrinos.

10:00 am - Yudai Suwa, Two-dimensional simulation with the spectral neutrino transport

Abstract: I will talk about our recent results based on the two-dimensional hydrodynamic simulation including neutrino radiation transport.

11:00 am - Coffee

11:30 am - Projjwal Banerjee, Neutrino-Driven Nucleosynthesis in Metal-Poor Stars

12:30 pm - Lunch

3:00 pm - Irene Tamborra, Diffuse supernova neutrinos: an updated analysis

Abstract: I'll discuss the most recent estimation of the diffuse supernova neutrino background obtained using progenitor-dependent, long-term supernova simulations and including neutrino oscillations for several post-bounce times.

4:00 pm - Tea Time (and Coffee)

4:30 pm - Matthias Hempel, New equations of state in core-collapse supernova simulations

Abstract: New equations of state (EOS) which are available for use in astrophysical simulations are presented. Their characteristic properties are confronted with experimental and observational constraints. The role of the EOS in core-collapse supernovae is analyzed by use of spherical simulations with detailed neutrino transport. The discussed aspects include the distributions of heavy nuclei during collapse, the abundant appearance of light nuclei like deuterons and tritons in the shock heated matter and the role of the high-density EOS in the later post-bounce phase. Also the EOS imprint on the neutrino signal is analyzed. In addition to the properties of the cold nuclear matter EOS, we find that also temperature effects can be crucial for the dynamics, which show an interesting, non-trivial model dependency.

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Week 3 (7/9-7/13)

Monday 7/9

10:30 am Chris Fryer, Using NuSTAR to probe asymmetries in core-collapse supernovae

Abstract: NuSTAR, the Nuclear Spectroscopic Telescope Array, was successfully launched June 13 and will begin taking scientific data in July. Its high spatial resolution, and sensitivity in the 5-80keV range, make it ideal for mapping out radioactive titanium distributions in supernova remnants and measuring down-scattered gamma-rays from nickel decay. Both of these observations provide clues to the production and outward mixing of these key isotope probes of the supernova engine. I will review current plans for and discuss on-going studies of NuSTAR's core-collapse supernova program.

3:00 pm Discussion: NuSTAR, Led by Aimee Hungerford

Tuesday 7/10

10:30 am Gang Shen, EOS and Consistent Neutrino Opacity

3:00 pm Discussion: EOS, Matthias Hempel, Gang Shen, Jim Lattimer

Wednesday 7/11

10:30 am Yeunhwan Lim, Finite-range Models for EOS

3:00 pm Discussion: X-ray Bursts, led by Brendan Krueger

Thursday 7/12

10:30 am Lorenz Hudepohl, Neutrino Oscillation Studies in Core-Collapse Supernovae

3:00 pm Discussion: Simulations, led by Christian Cardall

Friday 7/13

10:30 am Carla Fröhlich, The neutrino-p-Process: Critical Nuclear Physics and Astrophysical Implications

Abstract: The neutrino-p-process is thought to occur in the innermost proton-rich layers ejected in core-collapse supernovae. The importance of the νp process lies in the fact that it may contribute to the abundances of elements above Nickel and possibly the light p nuclei. The reaction path of the νp process lies in a region where nuclear masses are partly unknown and all involved reaction rates are based on theoretical predictions. I will report on a detailed study of the neutrino-p-process nucleosynthesis and its uncertainty due to the nuclear physics, focussing on the reaction path at and above ^{56}Ni . I will identify the critical nuclear physics input and discuss the impact of uncertainties on the resulting nucleosynthesis. I will conclude by discussing the implications for understanding the origin of the elements beyond Nickel.

3:00 pm Discussion: TBA

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Week 4 (7/16-7/20)

All talks are in room C520. A total of one hour is allotted for each talk. The speaker has 30-45 minutes to present, and the rest is intended for discussion.

Monday 7/16

8:00 am - Registration in room C411

9:00 am - Schuyler Van Dyk, Direct Identification of Core-Collapse Supernova Progenitors

10:00 am - Ken Nomoto, Progenitor's evolution and explosion of Type IIb supernova 2011dh in M51

11:00 am - Coffee

11:30 am - Zachary Jennings, Core-Collapse Supernova Progenitors from Stellar Population synthesis

12:30 pm - Lunch

3:00 pm - Dave Arnett, TBA

4:00 pm - Tea Time (and Coffee)

4:30 pm - Elena Pian, State of the art of GRB-Supernova connection observations

Tuesday 7/17

9:00 am - Robert Fesen, Cas A: A Detailed Look at the Kinematics and Structure of a SN IIb Explosion

10:00 am - Dan Milisavljevic, Unraveling the Explosion Geometries of Core-Collapse Supernovae From Their Late-time Optical Emissions

11:00 am - Coffee

11:30 am - Daniel Patnaude, What Do X-ray Observations of Supernova Remnants Tell Us About Supernovae and Their Progenitors

12:30 pm - Lunch

3:00 pm - Yong-Zhong Qian, Neutrinos, Nucleosynthesis, and Core-Collapse Supernovae

4:00 pm - Tea Time (and Coffee)

4:30 pm - Gail McLaughlin, Neutrino Flavor Transformation in Supernovae and Accretion Disks: Implications for Nucleosynthesis

Wednesday 7/18

9:00 am - Christian Ott, Studying Core-Collapse Supernova Physics with Gravitational Waves

- 10:00 am** - Kei Kotake, Brainstorming on core-collapse supernova theory with some perspectives toward multi-messenger astronomy
- 11:00 am** - Coffee
- 11:30 am** - Ernazar Abdikamalov, New approaches to multi-dimensional radiation transport
- 12:30 pm** - Lunch
- 3:00 pm** - Annop Wongwathanarat, Neutrino and GW signals from 3D core-collapse simulations
- 4:00 pm** - Tea Time (and Coffee)
- 4:30 pm** - Juergen Schaffner-Bielich, Signals from the QCD Phase Transition in Compact Stars

Thursday 7/19

- 9:00 am** - H.-Thomas Janka, Exploring the progenitor-remnant-explosion connection by neutrino-driven explosion models Structure of a SN I Ib Explosion
- 10:00 am** - Paolo Mazzali, SNe Ib/c with and without Gamma-ray Bursts
- 11:00 am** - Coffee
- 11:30 am** - Masaomi Tanaka, 3D Geometry of Supernovae: Spectropolarimetric Observations
- 12:30 pm** - Lunch
- 3:00 pm** - Stanley Yen, The HALO Supernova Neutrino detector
- 4:00 pm** - Tea Time (and Coffee)
- 4:30 pm** - David Cline, Study of Flavor Neutrino Swap with the 10KT LBNL Liquid Argon Detector

Friday 7/20

- 9:00 am** - Cecilia Lunardini, Diffuse supernova neutrino background
- 10:00 am** - Benedikt Riedel, Supernova Neutrino Detection with IceCube - Overview and Outlook
- 11:00 am** - Coffee
- 11:30 am** - Tina Lund, Neutrino flavor evolution through turbulent supernova matter
- 12:30 pm** - Lunch
- 3:00 pm** - Ronald Bruijn, A novel method for supernova detection in IceCube and beyond
- 4:00 pm** - Tea Time (and Coffee)
- 4:30 pm** - Closing Remarks

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Week 5 (7/23-7/27)

Monday 7/23

10:30 am Tina Lund, Fast Time Variations of Neutrinos in IceCube

3:00 pm Discussion, Supernova Neutrinos

Tuesday 7/24

10:30 am Wick Haxton, Dark Matter and Neutrino Responses

3:00 pm Discussion, Neutrino theory

Wednesday 7/25

10:30 am Charles Horowitz, Equation of state and neutrino interactions in supernovae

3:00 pm EOS

Thursday 7/26

10:30 am Christian Ott, Bayesian model selection of SN Mechanism based on Gravitational Wave Observations

3:00 pm Multimessenger Observations

Friday 7/27

10:30 am Thierry Foglizzo, Hydrodynamic Instabilities

3:00 pm Closing Remarks