

Stellar Evolution, Supernova and Nucleosynthesis Across Cosmic Time

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We hosted a Kavli IPMU workshop on “Stellar Evolution, Supernova and Nucleosynthesis Across Cosmic Time,” for two weeks from 18 September to 29 September 2017. The workshop was also to celebrate the career and achievements of Kavli IPMU Professor Ken’ichi Nomoto in the field of stellar evolution and supernova explosions on the occasion of his 70th birthday. We invited active researchers in related fields from all over the world. In total, we had 81 participants including 46 researchers from foreign institutes (24% of whom were female). This international spectrum of participants was engaged in active discussion on “massive star evolution and core-collapse supernovae,” “low and intermediate mass star evolution and type Ia supernovae,” “asymptotic giant stars and electron capture supernovae,” and “chemical evolution and Galactic Archeology.”

It was organized in a workshop style, namely we tried to limit the number of talks every day, and encouraged discussion and collaboration. The review talks were arranged for the morning, while the afternoon was for discussions. Ken’ichi Nomoto offered free beers in the cafeteria every evening, which stimulated discussion in an informal and friendly atmosphere. There were 39 talks in the morning sessions, and 25 informal talks in the afternoon sessions. This workshop style is an experiment at the Kavli IPMU. This required the invaluable help of the Kavli IPMU secretaries,

without whom it would have been impossible to have this successful meeting. The workshop style was well-received by many participants, and we believe this could be one possible direction for future Kavli IPMU activities.

The first week mainly dealt with topics related to massive stars and core-collapse supernovae. On Monday, Norbert Langer gave a broad review of the current status of the massive star evolution and open questions, which was then followed by several talks on the up-to-date observational status. On Tuesday, Adam Burrows summarized the latest issues related to the theory of core-collapse supernova explosions, and several talks followed to address relations between massive star evolution and the supernova explosion mechanism. Galactic Archeology was a topic on Wednesday, led by a review by Chris Sneden on observations of metal-poor stars. Ken’ichi Nomoto detailed how supernovae from the first stars would have polluted our galaxy with heavy elements. One of the topics on Thursday was supernova nucleosynthesis, exemplified by a review by Marco Limongi. On Friday, various new types of transients were discussed, led by Chris Fryer, covering highly topical issues on super-luminous supernovae, gamma-ray bursts, and electro-magnetic counterparts of binary neutron star mergers.

The second week mainly dealt with topics related to low-/intermediate-mass stars and type

la supernovae. On Monday, Ken'ichi Nomoto provided a review of one of his most influential fields of study, namely the evolution of intermediate mass stars and electron capture supernovae. Tuesday morning was on the long-debated issue of progenitor evolution toward type Ia supernovae, where the so-called single degenerate scenario (talk given by Izumi Hachisu) and double degenerate scenario (by Ashley Ruiter) were discussed, followed by observational constraints as reviewed by Mark Sullivan and Kate Maguire. The explosion mechanisms were discussed on Wednesday. Various models were discussed in the session, following an overview review by Friedrich Roepke. On Thursday, Peter Nugent presented exciting new discoveries by the iPTF survey, and discussion on supernova light curves and spectra followed. On Friday, Chiaki Kobayashi reviewed the galactic chemical evolution, emphasizing in particular the importance of feedback from low-/intermediate-mass stars and type Ia supernovae. This was then followed by Naoki Yasuda's talk on transient survey program(s) with Subaru/HSC. The two-week workshop was closed with talks by Wolfgang Hillebrandt and Philipp Podsiadlowski, who summarized the open questions of supernova study and possible future directions in the coming decade.

During the workshop period, two of the participants provided APEC seminars. Philipp

Podsiadlowski gave a review of the highly topical issue of gravitational wave sources, including mergers of binary black holes and binary neutron stars. Francesca Matteucci, a pioneer in the field, provided a review of the chemical evolution and Galactic Archeology, covering everything from the basics to the most recent update. The lecture room was nearly full for both of the seminars, and both were followed by active discussions among the workshop participants and Kavli IPMU researchers.

On Wednesday evening of both weeks, a buffet-style banquet, complete with sushi stand, was held at a nearby Japanese restaurant. About 50 participants and their families enjoyed meals and conversation at each banquet. Friedel Thielemann and Melina Bersten in the first banquet, and Francesca Matteucci and Wolfgang Hillebrandt in the second, gave enjoyable speeches and showed many slides to celebrate Ken'ichi Nomoto's 70th birthday.

It was very impressive to observe that the field of stellar evolution, supernovae and transients, as pioneered by Ken'ichi Nomoto, is now rapidly expanding. The Subaru/HSC transient survey, which involves many IPMU researchers, is still young, but has started reporting many interesting results. We are hoping that these exciting fields of astronomy keep expanding in the future, and after this successful workshop we have no doubt that they will.



The 1st week banquet on September 20



The 2nd week banquet on September 27