

Focus Week: Messengers of Supernova Explosions

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Some stars end their lives with a gigantic “supernova explosion.” They become so bright, typically as bright as the host galaxy that contains more than 10 or 100 billions of stars, that the light even from the supernovae taking place far away in the Universe is detectable on the Earth. Observations such as these led to the discovery of dark energy in the Universe. To identify the nature of this enigmatic dark energy, it is necessary to deepen our theoretical understanding of supernovae, as well as to perform very accurate observations.

A supernova explosion is a complex phenomenon, with various branches of physics taking roles in it. As such, our understanding of supernova explosions is still far from satisfactory. From 17 to 21 November, 2008, we hosted an IPMU Focus Week entitled “Messengers of Supernova Explosions,” with the aim of identifying unresolved problems and then coming up with new ideas to solve them. We successfully gathered researchers working at the forefront of supernovae for this purpose. For invited speakers, we intentionally selected young researchers from various backgrounds, from both the theoretical and observational sides, to motivate new, synergistic approaches.

The following is a brief summary of the talks presented at this Focus Week. A supernova is triggered by a catastrophic gravitational collapse of a star, producing a large amount of neutrinos. Direct observations of such neutrinos will lead to the discovery of new neutrino physics (George Fuller/UCSD, Alexander Kusenko/UCLA). The accumulation of neutrinos emitted in a number of past supernovae is expected



to be detected by Super-Kamiokande in the near future, which will provide an insight on how many supernovae have taken place in the Universe (Mark Vagins/IPMU). Spectroscopic observations of supernovae in optical and infrared wavelengths are strong tools to investigate the still-unknown mechanism of supernova explosions (Christopher Gerardy/Florida State Univ., Lifan Wang/Texas A&M, Keiichi Maeda/IPMU). Recent developments in observational methods have led to the discovery of new types of supernovae, which are either extremely bright or faint (Peter Nugent/LBNL, Giuliano Pignata/Chile, Sergei Blinnikov /ITEP · IPMU). Studying these phenomena will provide hints on stellar evolution theory (Marco Limongi/Roma Obs. · IPMU) and on the explosion mechanism (Steve Bruenn/Florida Atlantic Univ., Chris Fryer/LANL). We also expect improvements in supernova cosmology (Mario Hamuy/Chile, Mamoru Doi/U.Tokyo · IPMU). Supernovae are the origins of various elements in the Universe (Shinya Wanajo/IPMU, Hideyuki Umeda/U.Tokyo), which can be directly tested by observing Galactic supernova remnants (Hiroshi Tsunemi/

Osaka Univ.). The variety of information mentioned above was summarized in terms of supernova luminosity and the masses of the progenitor stars (Ken'ichi Nomoto/IPMU), which motivated intensive discussion on how to tackle the unresolved problems clarified during this Focus Week.

Each talk was followed by plenty of time for discussion following the successful format of the previous Focus Week workshops. Discussion hours of about two hours were held in the afternoon, with offices and WLAN available for the participants. Holding the discussion hours turned out to be very fruitful, as the participants planned new collaborative projects during this free time. In organizing the Focus Week, we managed to create an atmosphere in which everyone felt relaxed. The participants took dinner together every evening, and also went on an excursion to Tokyo on the Thursday afternoon. These efforts were welcomed by the participants. The Focus Week was very successful; most participants presented really new, unpublished results, and everyone became involved in intense discussions based on these new results.