# Extremely efficient fully three-dimensional hydrodynamic simulations of supernova remnants to service the era of micro-calorimetric X-ray astronomy

- **講師**
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- **日程**
  **9/15 16:20~17:50 (5限)**
- **場所**
  **埼玉大学理学部 2号館2階8番教室**
- **講義内容**
  Until the last decade or so, three-dimensional simulations of supernova remnants (SNRs) have been performed by a limited number of groups in the world with one main thing in mind - evolving their bona fide supernova (SN) explosion models to the remnant phase. These models only exist in small numbers because of their huge computational costs, and they do not necessarily match with the real remnants out there in space since they are derived from supernova models in which many physical uncertainties still remain. The burden of interpreting observations (especially X-ray observations) has thus been put on the shoulders of more phenomenological 1-D models coupled with atomic physics calculations whose computational efficiency allows for large-scale parametric surveys to confront observational data. However, in the upcoming era of micro-calorimetric spectroscopy made possible by next generation instruments such as XRISM and ATHENA, we can expect that the amount of details in the observational data will easily go beyond the capacity of these 1-D models, and the comparison with which will no longer bring us fruitful results which can be obtained only by fully utilizing the information encoded in the anticipated high-resolution spectra. We must seek to step up in our game on the front of modeling.

  On this end, one effective path is to realize a pipeline capable of synthesizing robust X-ray spectra in a practically short enough computational time without losing the 3-D information from supernova explosion models. Using techniques such as co-moving grids and particle tracers, we have succeeded to develop a platform which can produce a full-fledged 1,000 year old SNR from 3-D SN models (e.g., one day after explosion), using a simulation time within one Earth day on a personal computer. Along with the hydrodynamic evolution, the particle tracer method allows for the tracking of the detailed plasma state inside the remnant such as the non-equilibrium ionization states and temperatures in an element-specific way. The spatial distribution of different ion species as well as their velocities and temperatures are recorded in these 3-D models at all ages, from which X-ray spectra with realistic emission line profiles can be synthesized after projecting them on the sky. In this talk, I will introduce the methodology behind these 3-D models, including a few examples for both the core-collapse and thermonuclear camps for illustration. Results from observation simulations and spectral syntheses based on these 3-D models will also be shown for instruments including XRISM. We aim at providing a convenient package which observers can use to interpret data in the future, presumably in the form of an extensive library of X-ray spectral templates from a combinational variety of progenitor stars, explosion environments and evolutionary stages.

# 京都大学ハーマン先生の宇宙物理学のセミナーは、9月15日（本日）５限に４番教室です。


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## Title:

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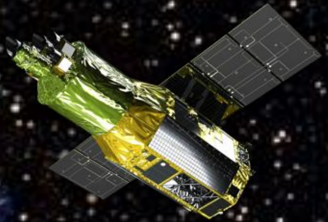

## Abstract:


Until the last decade or so, three-dimensional simulations of supernova remnants (SNRs) have been performed by a limited number of groups in the world with one main thing in mind - evolving their bona fide supernova (SN) explosion models to the remnant phase.These models only exist in small numbers because of their huge computational costs, and they do not necessarily match with the real remnants out there in space since they are derived from supernova models in which many physical uncertainties still remain.The burden of interpreting observations (especially X-ray observations) has thus been put on the shoulders of more phenomenological 1-D models coupled with atomic physics calculations whose computational efficiency allows for large-scale parametric surveys to confront observational data. However, in the upcoming era of micro-calorimetric spectroscopy made possible by next generation instruments such as XRISM and ATHENA, we can expect that the amount of details in the observational data will easily go beyond the capacity of these 1-D models, and the comparison with which will no longer bring us fruitful results which can be obtained only by fully utilizing the information encoded in the anticipated high-resolution spectra.We must seek to step up in our game on the front of modeling. On this end, one effective path is to realize a pipeline capable of synthesizing robust X-ray spectra in a practically short enough computational time without losing the 3-D information from supernova explosion models. Using techniques such as co-moving grids and particle tracers, we have succeeded to develop a platform which can produce a full-fledged 1,000 year old SNR from 3-D SN models (e.g., one day after explosion), using a simulation time within one Earth day on a personal computer. Along with the hydrodynamic evolution, the particle tracer method allows for the tracking of the detailed plasma state inside the remnant such as the non-equilibrium ionization states and temperatures in an element-specific way. The spatial distribution of different ion species as well as their velocities and temperatures are recorded in these 3-D models at all ages, from which X-ray spectra with realistic emission line profiles can be synthesized after projecting them on the sky. In this talk, I will introduce the methodology behind these 3-D models, including a few examples for both the core-collapse and thermonuclear camps for illustration. Results from observation simulations and spectral syntheses based on these 3-D models will also be shown for instruments including XRISM. We aim at providing a convenient package which observers can use to interpret data in the future, presumably in the form of an extensive library of X-ray spectral templates from a combinational variety of progenitor stars, explosion environments and evolutionary stages.