# Numerical Radiation Hydrodynamics in Astrophysics

Radiation emitted by astronomical objects such as stars and galaxies plays important roles in the time evolution of our universe. However, the numerical calculations of physical effects by such radiation field need huge computational costs and it is a great challenge to investigate the formations of stars and galaxies with numerical radiation hydrodynamics, a self-consistent simulation of hydrodynamics incorporated with the effect of radiation .
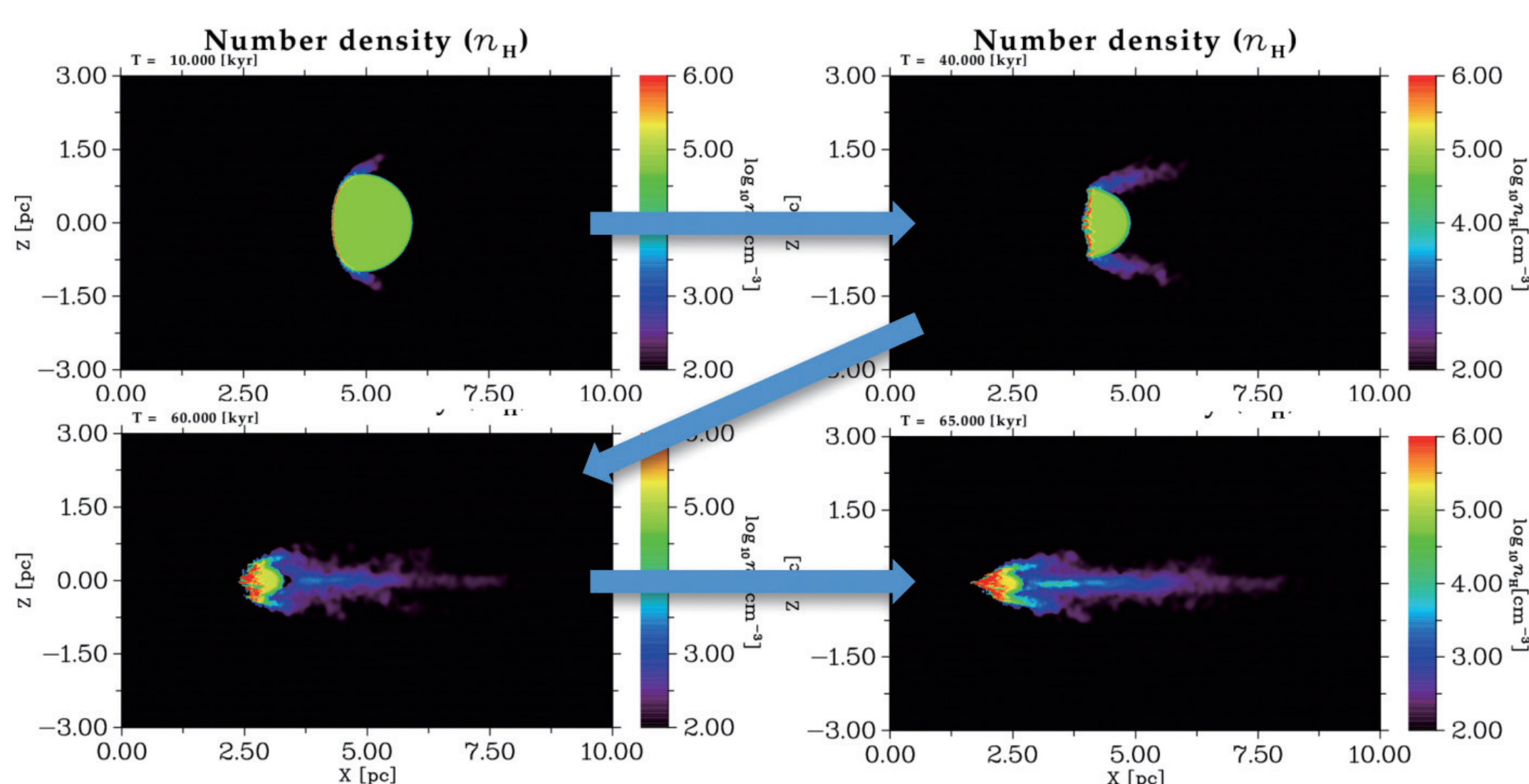
Numerical simulation in astrophysics

Since the numerical simulations of radiation hydrodynamics requires large computational resources, we develop efficient methods for computing physical effects of the cosmic radiation, including the use of GPU accelerators. With the aid of such techniques, we are able to conduct radiation hydrodynamic simulations with unprecedented accuracy.
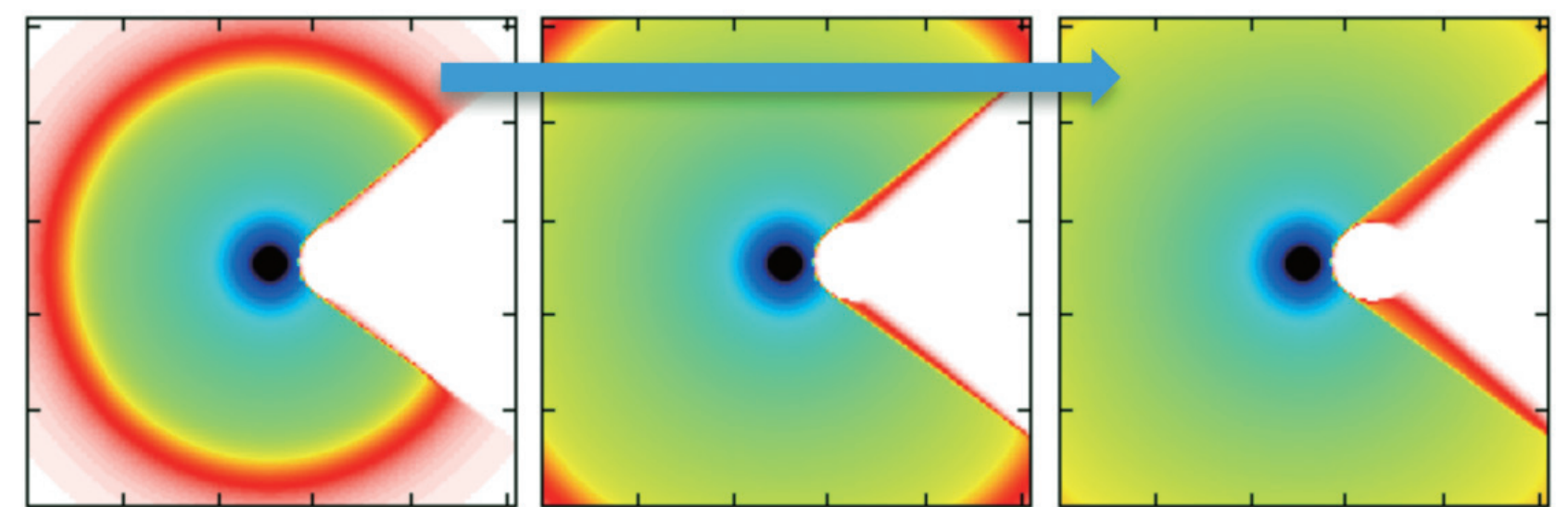
These figures depict the time evolution of ionization state of gas around a point-like radiating source located at the left side the dense gas cloud indicated by the solid circle

Gas cloud falling into massive black holes

Active galactic nucleus (AGN) is a compact region in center of galaxies, hosting a super-massive black hole, and has a much larger luminosity than normal galaxies. Figures show the numerical simulation of a gas cloud irradiated by an AGN located at the left side of the figures. The strong radiation pressure by the AGN strips significant amount of gas from the clouds.

Global ionization in the early universe

The universe once neutralized during the cosmic recombination era is presumed to be ionized by the UV radiation emitted by primordial stars and galaxies in the early universe. Figures show how the primordial galaxies ionize the universe based on the state-of-the-art radiation hydrodynamic simulations of the early universe.