X36a Evolution of high-redshift quasar hosts and promotion of massive black hole seed formation

稲吉恒平 (北京大学/KIAA)

High-redshift luminous quasars powered by accreting supermassive black holes (SMBHs) with mass $\gtrsim 10^9\ M_\odot$ constrain their formation pathways. We investigate the formation of heavy seeds of SMBHs through gas collapse in the quasar host progenitors, using merger trees to trace the halo growth in highly-biased, overdense regions of the universe. The progenitor halos are likely irradiated by intense H_2-photodissociating radiation from nearby star-forming galaxies and heat the interior gas by successive mergers. The kinetic energy of the gas originating from mergers as well as baryonic streaming motion prevents gas collapse and delays prior star formation. With a streaming velocity higher than the root-mean-square value, gas clouds enter the atomic-cooling stage and begin to collapse isothermally with $T \simeq 8000$ K via Lyα cooling. The fraction of trees which host isothermal gas collapse is $\sim 14\%$ and increases with streaming velocity, while the rest form H_2-cooled cores after short isothermal phases. In the massive collapsing gas, a newly-born protostar grows via mass accretion at rates of $\sim 10^{-2} - 1\ M_\odot\ \mathrm{yr}^{-1}$. As a result, we expect a distribution of stellar mass (presumably BH mass) ranging from several hundred to above $\sim 10^5\ M_\odot$, potentially forming massive BH binary mergers and yielding gravitational wave events. In this talk, we describe the key physics of this new scenario and provide applications of the BH mass function in the early universe.