Titans of the Early Universe

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Abstract: In order to trace the origin of the great multitude of elements in the Universe, we must understand the lives of the first stars and galaxies, and the environment in which they formed. This is especially true of the most massive objects originating in that time. The existence of truly supermassive stars, with masses of order 100,000 times that of the Sun, was first suggested over 50 years ago. However, only recently has it become increasingly apparent that such objects must necessarily have formed in the early Universe. They are needed in order to explain the origin of the most massive high-redshift quasars now observed (having grown to a billion solar masses in the first billion years). These objects are born under sustained, unusually high accretion rates of order a solar mass per year, in the collapse of massive, atomically-cooled halos irradiated by nearby star-forming regions. This is only possible for essentially pristine, primordial gas. In its final moments, the resulting supermassive star collapses through the general relativistic instability, typically with a central hydrogen fraction of order 50%. This renders them a spectacular site of rp-process nucleosynthesis – but whether any products of this can escape is unknown, likely depending critically on the prior accretion of mass and angular momentum. Before collapse, pulsational instabilities may also lead to mass loss and chemical enrichment of the surrounding medium, but this too remains uncertain. Theoretically, new advances are needed in numerical modeling of accretion, stellar evolution, and cosmic structure. Observationally, preparations are needed in haste for the advent of the James Webb Space Telescope, which will finally reveal the lives of these truly extraordinary stars, and their role in the early Universe.

Goals: This workshop will assemble leading experts from stellar evolution, star formation, accretion physics, and cosmology, in order to shed new light on the origin, evolution, and collapse of supermassive stars, as well as their life after death as the progenitors of the first massive quasars. The primary objective will be to review, discuss, and bring together the latest developments in the study of primordial supermassive stars. New insight is needed into the coupling of the evolution of these stars and the surrounding gas, the moment of their collapse, the role rotation plays in their evolution, and more. We also hope to consolidate the latest relevant breakthroughs made across several disparate lines of research in a review article published after the workshop.

Topics:

- Star formation in the early Universe
- Exotic nucleosynthesis during the collapse of supermassive stars
- Accretion physics in massive, atomically-cooled halos
- Direct collapse black holes and the origin of the first quasars
- Gravitational waves from collapsing supermassive stars
- The collapse of rotating supermassive stars
- Mass return and chemical enrichment from supermassive stars
- Recent observational evidence for supermassive stars
- Intermediate mass black holes
- Prospects in the era of the James Webb Space Telescope
- Expected rates from cosmological simulations

Attendance of the workshop is by invitation only. If you are interested in joining this workshop, please contact the organizer Tyrone Woods tewoods.astro@gmail.com

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Center for the Evolution of the Elements