Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **4** Type: **Invited Speaker / Conférencier(ère) invité(e)**

The Mass and Luminosity Function of Supermassive Black Holes in the Direct Collapse Scenario

Thursday, June 11, 2020 12:30 PM (15 minutes)

A key challenge to the standard cosmological model is the observation of very massive (M > 10^9 Msun) and luminous (L > 10^{13} Lsun) quasars already in place by z~7, when the age of the universe was just ~800 Myr. The formation of such supermassive black holes (SMBH) cannot generally occur in the time available if starting from stellar mass black holes. We explore implications of the idea of direct collapse black holes (DCBH) emerging from the collapse of a special class of supermassive stars (~ 10^5 Msun) that could only form at high redshift in so-called atomic cooling halos. Both numerical and semi-analytic modeling implies a brief period of rapidly growing production of supermassive stars, in the approximate redshift range of z~20 to z~13. Our work shows that the mass function of SMBHs after a limited time period of rapid formation of DCBH, coupled with a super-Eddington accretion from their host halos, can be described as a tapered power law function. The power law at intermediate masses has an index that is the dimensionless ratio alpha = lambda/gamma, where lambda is the growth rate of the number density of DCBHs during their formation era, and gamma is the growth rate of DCBH masses by super-Eddington accretion during the same growth era. A second feature is a break in the power-law profile at high masses, above which the mass function declines rapidly. This mass distribution is largely set during this early growth era, and subsequent mass growth may be more limited. We also calculate the implied luminosity function of the resulting SMBH, which is in remarkable agreement with the broken power law quasar luminosity function that has been observed at high redshift.

Authors: Prof. BASU, Shantanu (University of Western Ontario); Mr DAS, Arpan (University of Western Ontario)

Presenter: Prof. BASU, Shantanu (University of Western Ontario)

Session Classification: R-DTP-1: Theoretical Physics I

Track Classification: Theoretical Physics / Physique théorique (DTP-DPT)