P138a Supermassive Star Formation in Magnetized Atomic-cooling Gas Cloud

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The origin of super-massive black holes (about one billion solar-masses) in the early universe (redshift $z \sim 7$) remains poorly understood. Gravitational collapse of a massive primordial gas cloud is a promising initial process, but theoretical studies have difficulty growing the black hole fast enough. We focus on the magnetic effects on the star formation occurring in the atomic-cooling gas cloud. Using a set of three-dimensional magnetohydrodynamical simulations, we investigate the star formation process in the magnetized atomic-cooling gas cloud with different initial magnetic field strengths.

Our simulations show that the primordial magnetic seed field can be quickly amplified during the early accretion phase after the first protostar formation. The strong magnetic field efficiently extracts angular momentum from accreting gas and increases the accretion rate, which results in the high fragmentation rate in the gravitationally unstable region. On the other hands, the coalescent rate of fragments is also enhanced by the angular momentum transfer due to the magnetic effects. Almost all the fragments coalescent to the primary star so the mass growth rate of the massive star increases due to the magnetic effects. We conclude that the magnetic effects support the direct collapse scenario of the massive star formation.