Q41a An origin of high velocity compact clouds: Dynamical signature of intermediate mass black holes

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Recently, new evidence of intermediate-mass black hole has been suggested by Oka et al. (2016). They observed molecular line emission from a high velocity compact molecular cloud (CO-0.40-0.22) in the central molecular zone (CMZ) of Milky Way Galaxy using radio telescope. The CO-0.40-0.22 cloud possesses extremely broad velocity width $\sim$ 100km/s. They suggested that such a peculiar velocity structure is caused by gravitational scattering of a 10^5 solar mass black hole by comparing simple test particle orbits. Such an existence of an intermediate mass black hole may provide a support for the "bottom-up" formation scenario of massive black holes. However, their interpretation of the observation of large velocity dispersion neglected the effects of catastrophic heating, dissociation, and ionization by tidal compression and shock wave propagation during the gravitational scattering process. These effects may drastically change the gas state and the appearance of molecular line emissions. To analyze more realistic dynamics of gravitational scattering of a cold molecular cloud, we perform full 3D hydrodynamics simulations using a newly implemented high-resolution shock capturing numerical scheme called "Godunov smoothed particle hydrodynamics" (Inutsuka 2002) with non-equilibrium chemistry and radiative cooling/heating effects (Koyama & Inutsuka 2000)).