Apr 22nd, 11:00 AM - 12:00 PM

Gas Kinematics Determination of the Black Hole Mass of NGC 4258

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Abstract

NGC 4258 is an important galaxy for comparing methods of supermassive black hole mass measurement. Radio (VLBA) observations of water masers in its nuclear disk has allowed a very precise estimate of the mass of the central SMBH ($3.9 \pm .1 \times 10^7 M_\odot$), and the distance to the galaxy (7.6 Mpc). Hubble Space Telescope (HST) archival data allow the measurement of the BH mass in two additional, independent ways: stellar kinematics and gas kinematics, thus providing a crucial test of these more widely-used methods. Here we report on progress in a re-analysis of the archival data allowing gas kinematics. These data consist of HST long-slit spectra from two programs, for a total of 6 slit positions. We have fitted the Hα + [NII] and [SII] lines in order to determine radial velocities, velocity dispersions, and emission line strengths as a function of distance from the BH. The thin disk model matches velocity profiles well in all slits to $\sim 0.4''$. We use χ^2 functions to measure the fit quality of our models compared to real data, with the best models finding a mass of about $5.6 \times 10^7 M_\odot$ and a disk inclination of 46°. This result is between the aforementioned water maser value and prior gas kinematics work by Pastorini et al. (2007) of $7.9 \times 10^7 M_\odot$.