# Supermassive Black Holes In Galaxy Nuclei

Kormendy (DAO) continues a search for nuclear black holes (BH) by measuring stellar rotation and velocity dispersion profiles in early-type galaxies. The strongest evidence for a BH is in M31. Observations have been obtained with a slit width of $0\farcs5$, pixels of $0\farcs44$ and in seeing of $\sigma* = 0\farcs5$ (Gaussian dispersion of a star profile). Figure 10 shows some of the results. The well-known nucleus spins very rapidly. After correction for bulge light, the outer part of the nucleus has a velocity dispersion of only $\sigma \approx 94 \pm 4$ km s$^{-1}$. This is smaller than the bulge dispersion of 145 km s$^{-1}$, and implies that the nucleus is a disk. This greatly simplifies the derivation of the central mass-to-light ratio, since anisotropies in the velocity distribution are then not a major uncertainty. The central mass-to-light ratio is 20–35, depending on how much of the observed dispersion gradient is unresolved rotation. This is much higher than $M/L_V$ values observed in other galaxies. There is therefore strong evidence in M31 for a dark nuclear mass concentration, probably a black hole of mass $\approx 1 \times 10^7 M_\odot$.

In most galaxies, core properties do not lead in an obvious way to the formation of nuclear black holes. Stellar densities are too low and relaxation times too long for core collapse to take place. The central energy change relaxation time $t_r$ is $10^{12} - 10^{16}$ y for most galaxies. The exceptions are low-luminosity ellipticals like M32; with $t_r < 10^9$ y, M32 could have undergone core collapse. Interestingly, low-luminosity ellipticals are the ones least likely to be radio galaxies. To form supermassive black holes, it appears that we need to look for a process different from the formation of ellipticals and their cores as a whole. One possibility is gas infall leading to the formation of a dense nucleus like that in M31 and then to core collapse.

*J. Kormendy*

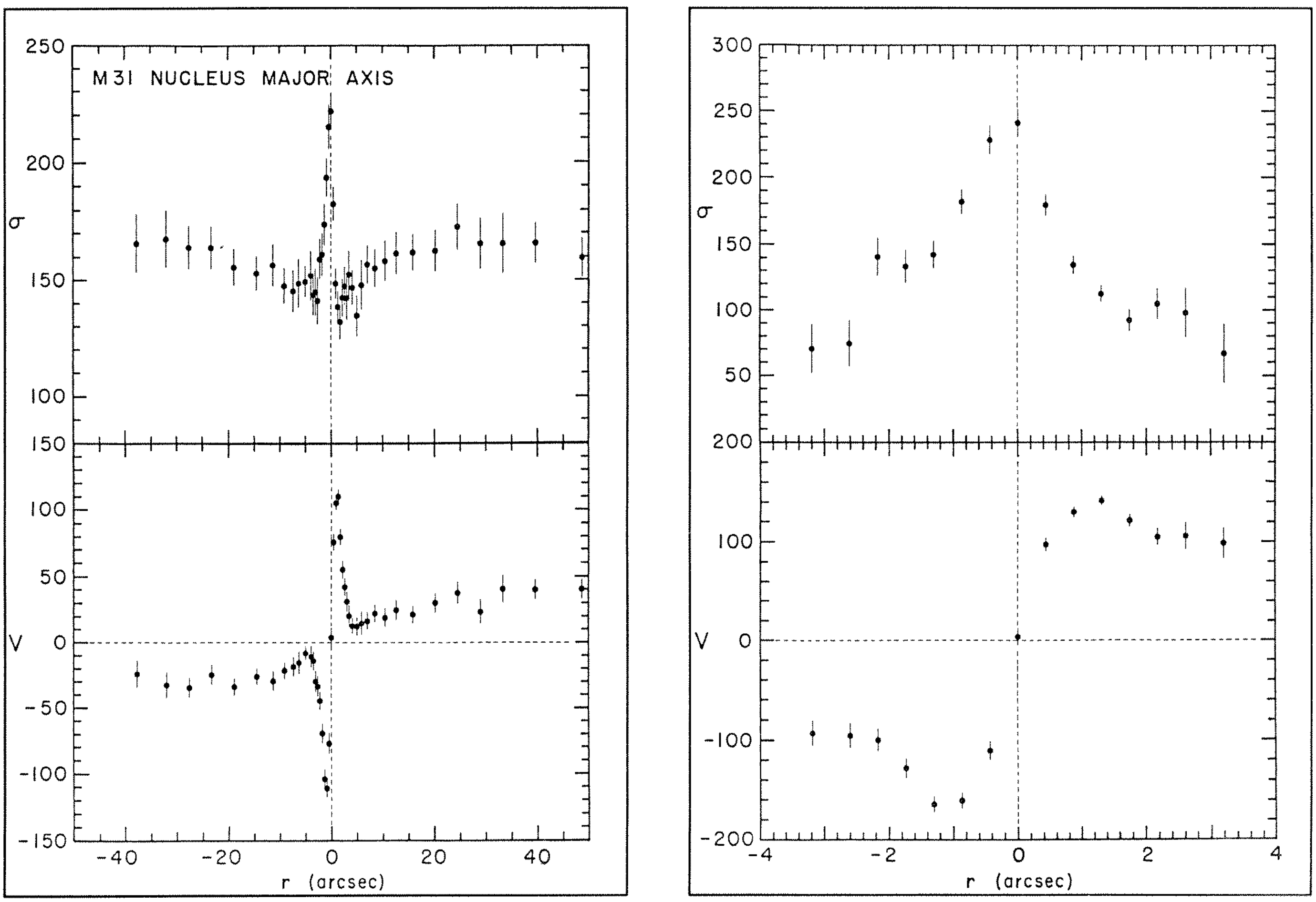


Figure 10: Rotation and velocity dispersion profiles of the nucleus of M31 before (left) and after subtraction of the bulge spectrum (right). The data were obtained with the Herzberg Spectrograph at f/4 and the RCA1 CCD camera.