

The Parsec-Scale Accretion Disk in NGC 3393

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Abstract.

We present a Very Long Baseline Interferometry image of the water maser emission in the nuclear region of NGC 3393. The maser emission has a linear distribution oriented at a position angle of $\sim 34^\circ$, perpendicular to both the kiloparsec-scale radio jet and the axis of the narrow-line region. The position-velocity diagram displays a red-blue asymmetry about the systemic velocity and the estimated dynamical center, and is thus consistent with rotation. Assuming Keplerian rotation in an edge-on disk, we obtain an enclosed mass of $(3.1 \pm 0.2) \times 10^7 M_\odot$ within 0.36 ± 0.02 pc (1.48 ± 0.06 mas), which corresponds to a mean mass density of $\sim 10^{8.2} M_\odot \text{pc}^{-3}$. We also report the measurement with the Green Bank Telescope of a velocity drift, a manifestation of centripetal acceleration within the disk, of $5 \pm 1 \text{ km s}^{-1} \text{ yr}^{-1}$ in the $\sim 3880 \text{ km s}^{-1}$ maser feature, which is most likely located along the line of sight to the dynamical center of the system. From the acceleration of this feature, we estimate a disk radius of 0.17 ± 0.02 pc, which is smaller than the inner disk radius (0.36 ± 0.02 pc) of emission that occurs along the midline (i.e., the line of nodes). The emission along the line of sight to the dynamical center evidently occurs much closer to the center than the emission from the disk midline, contrary to the situation in the archetypal maser systems NGC 4258 and NGC 1068. The outer radius of the disk as traced by the masers along the midline is about 1.5 pc.

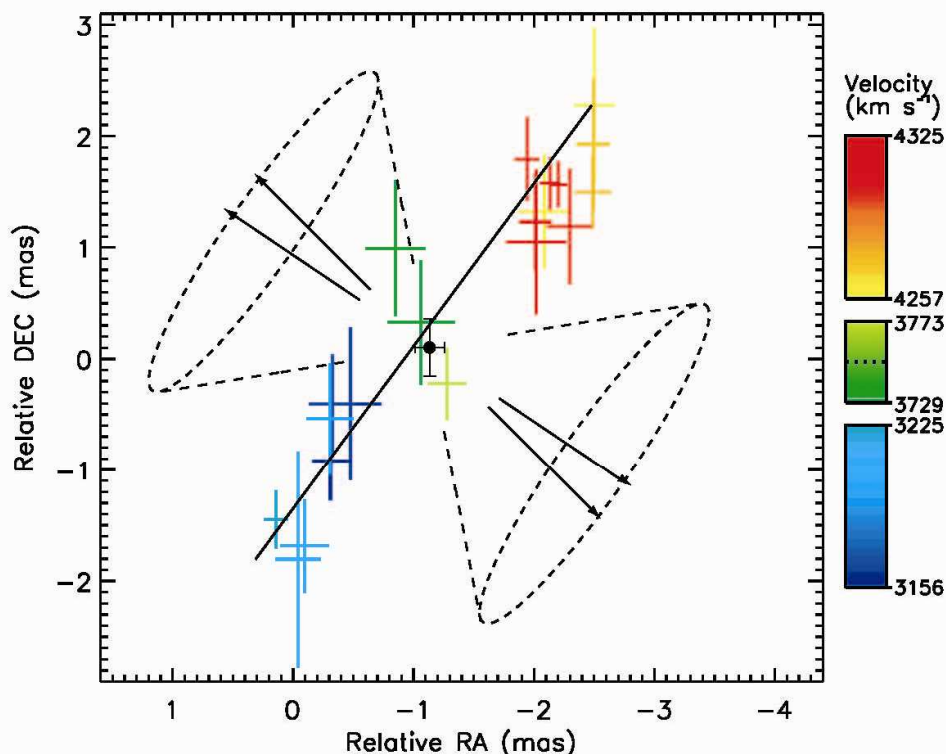


FIG. 2.—Distribution of maser emission in the nuclear region of NGC 3393. Position uncertainties are 1σ , and the colors of the maser spots indicate heliocentric optical line-of-sight velocity in accordance with the bar on the right. The dotted line in the color bar shows the adopted systemic velocity of 3750 km s^{-1} . The adopted location for the dynamical center (black circle) is the weighted mean for the low-velocity maser features. A line fitted to the distribution of maser emission on the sky (P.A. $\sim 34^\circ$) is close to orthogonal to the kiloparsec-scale radio jet (P.A. $\sim 45^\circ$, black arrows [Morganti et al. 1999]; $\sim 56^\circ$ [Schmitt et al. 2001b]) and to the axis of the NLR (dashed cone; P.A. $\sim 55^\circ$ with an opening angle of $\sim 90^\circ$ [Schmitt & Kinney 1996; Cooke et al. 2000]). The coordinates are relative to $\alpha = 10^{\text{h}}48^{\text{m}}23.4660^{\text{s}}$ and $\delta = -25^\circ09'43.478''$ (J2000.0). At a distance of 50 Mpc, 0.24 pc subtends 1 mas.