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Intermediate Resolution Hβ Spectroscopy and Photometric Monitoring of 3C 390.3. I. Further Evidence of a Nuclear Accretion Disk

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Abstract. The variations of the Hβ broad emission line and continuum flux in 3C 390.3 are investigated. Our results favor the formation of the broad Hβ line of 3C 390.3 in an accretion disk.

1. Observations

Spectroscopic monitoring of 3C 390.3 was carried out at the 6-m and 1-m telescopes of SAO RAS (Russia) and the 2.1-m GHO telescope at Cananea (México), in the range 4000-8000 Å, with a spectral resolution of 5-15 Å, and a S/N ratio of $\geq$50 in the Hβ region. Broad-band BVRI CCD photometric monitoring was carried out at the 1 m and 60 cm telescopes of SAO RAS, at the 60 cm telescope of the Crimean Laboratory of SAI (Russia) and at the 70cm meniscus telescope of Abastumani Observatory (Georgia).

2. Results

i. The continuum flux and the Hβ broad component varied by a factor of about three during the period 1995-1999 (Shapovalova et al., 2001).

ii. From a cross-correlation analysis, we found two values for the time lag in the emission line response relative to the continuum variations. In addition to the delay of ~100 days, obtained at any given time, we found a second value of ~35 days in periods of time when the sampling was better.

iii. The observed flux of the Hβ wings varied quasi-simultaneously, with the same lag relative to the continuum variations. This behavior excludes models of broad line formation in biconical gas streams or jets.

iv. The shift of the blue peak in integral Hβ profiles nearly follows the trend found by Eracleous et al. (1997). Their fitted model for a binary black hole with a very large mass ($\geq 10^{11} M_{\odot}$) seems to fit our data as well. Hence, our results provide further support for the dismissal of the binary black hole hypothesis for 3C 390.3, on the basis of the masses required.

v. The observed Hβ profiles are best reproduced by an inclined accretion disk (i=25°) whose region of maximum emission is located roughly at 200 R_g.

vi. From the difference profile of the Hβ line we found that the velocity variations of the blue and red bumps and their differences are anticorrelated with the Hβ flux variations and with the lag in the continuum (Shapovalova et all, 2001). Thus, the maximum of the line emission energy moves across the disk and corresponds to smaller radii when the continuum flux decreases (bump velocities increase), and to larger radii when the continuum flux increases (bump velocities decrease). These transient phenomena are expected to result from the variable accretion rate close to the black hole.

3. Conclusion

Our results do not support either the models of outflowing biconical gas streams or those of a supermassive binary black hole. Instead, our results are consistent with an accretion disk model.

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References

Eracleous, M., et al. 1997, ApJ, v. 490, p. 216

Shapovalova, A.I., et al. 2001, A&A, v. 376, p. 775