CONTINUUM AND BROAD EMISSION LINE VARIABILITY OF SEYFERT GALAXIES

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We focused on the observed properties of some Seyfert galaxies without detailed discussion of underlying physical mechanisms. Our purpose was to show a diversity of observed effects due to variability in spectra of six galaxies (NGC 4151, NGC 5548, Mrk 6, Ark 120, 3C 390.3, Arp 120B), optical spectral and photometric monitoring of which was carried out in the Crimean Astrophysical Observatory and Crimean Laboratory of the Sternberg Astronomical Institute over many years. This monitoring shows that

- All light curves demonstrate a variability on different time scales from days to years.
- Amplitude of variations increases with increasing of the time interval of observations.
- The flux in emission lines changes in response to the flux variation of the ionizing continuum source with some time delay. Thus, the emission lines "echo" or "reverberate" the continuum changes. This time delay is due to light-travel time effects within the BLR.
- The time delay of the broad Hβ emission line flux relative to optical continuum in the vicinity of the Hβ line lies in an interval from 9.2 days for Arp 102B to 80 days for 3C 390.3. This means that a region of the most effective emission in the Hβ and Hα lines is fairly small, and it is located at a distance of about 9 – 80 light days from the continuum source.
- We found one very strange and inexplicable case (3C 390.3) when a lag calculated from the broad Hα line significantly exceeds that of the Hβ. In all other cases, the Hα and Hβ lines have a similar lag.
- We revealed a slightly different lag for two time intervals for NGC 5548: $\sim$26 days in 1972–1988 and $\sim$ 18 days in 1989–2001.
- Analysis of the lag as a function of the radial velocity does not show any reliable evidence of the pure radial dominated outflow, possibly, except for NGC 4151. A weak evidence of radial inflow was found in Mrk 6 and Ark 120. Predominantly, we found that there is no pure radial inflow or outflow in the BLR of the considered galaxies. In all cases, the kinematics mainly looks like a chaotic or rotational motion.
- We also found that the lag for the central part of the broad Hβ emission line is slightly larger than for wings (NGC 5548).
- The lag slightly increases with increasing of the continuum flux (Ark 120). This fact is consistent with a virial relation between the velocity field and the distance of the emitting region: the velocity field diminishes with increasing distance from

the central continuum source. This implies that the velocity field is dominated by a central massive object.

- Not only the flux of broad emission line but also the line profiles appreciably changed with time. The emission-line profile changes usually occur on a time scale that is much longer than the light-travel time scale.

- In all cases, the excess between the normalized Balmer profiles and the mean normalized profile shows a very complicated behavior both over time and wavelength, and it can hardly be related to the expected reverberation signal from the simple disk model. The profile evolution for some galaxies (NGC 4151, Mrk 6, 3C 390.3) can be reproduced to larger or smaller extent with the two-component model in which profile changes are due to changes in the relative strength of two variable components with a fixed shape. The double peaked profile was often observed among the discussed objects. Profile decomposition gives one component that dominates in the central part of the profile, while the double peaked component dominates in the profile wings. However, the moving features of the profile shapes observed, e.g., in 3C 390.3, NGC 4151, and Arp 102B can be a result of rotating redistribution of matter in the Keplerian disk.

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