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Long-term variability of the optical spectra of NGC 4151

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Results of a long-term spectral monitoring of the active galactic nucleus of NGC 4151 are presented (11 years, from 1996 to 2006).

Keywords: Galaxies: active; Galaxies: individual: NGC 4151; Optical spectra: variability

1 Observations

High quality spectra (S/N > 50 in the continuum near Hα and Hβ) were obtained in the spectral range from 4000 to 7500 Å, with a resolution between 5 and 15 Å, using the 6-m and the 1-m SAO's telescopes (Russia), the GHAO's 2.1-m telescope (Cananea, Mexico), and the OAN-SPM's 2.1-m telescope (San-Pedro, Mexico). Spectra were scaled using the [OIII]5007 flux (for details, see Shapovalova et al. 2008).

2 Results

We found that the continuum and line fluxes varied strongly (up to a factor of 6) during the monitoring period. The emission was maximum in 1996–1998, and there

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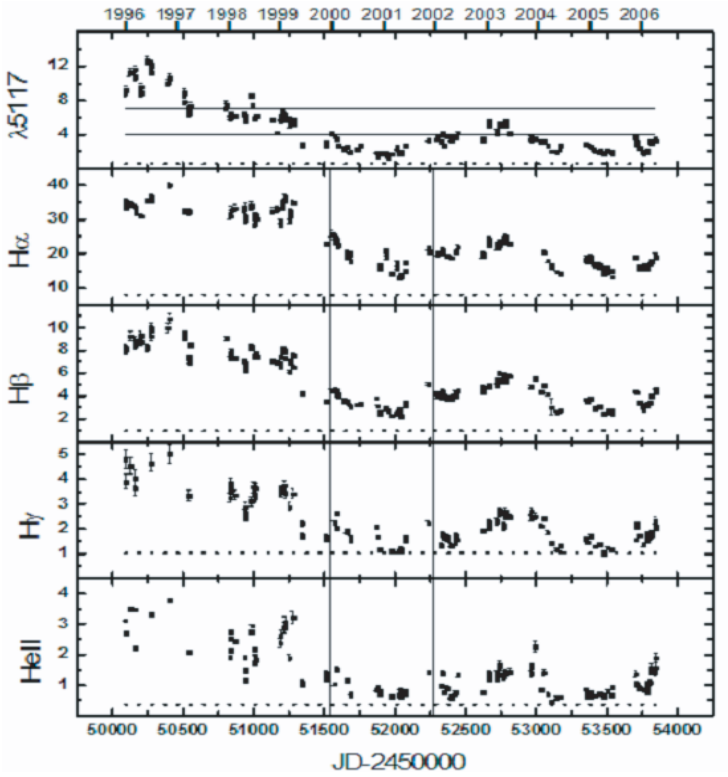


Figure 1 The light curves of Hα, Hβ, Hg and HeII4686 and of the continuum at the observed wavelength 5117 Å, in the period 1996–2006. Constant contributions from the narrow lines and from of the host galaxy are shown by horizontal dashed lines. The line fluxes are given in units of 10^{-12} erg cm^{-2} s^{-1}, and the continuum flux in units of 10^{-14} erg cm^{-2} s^{-1} Å^{-1}. The vertical lines correspond to the division into time intervals based on the similarity of the line shapes.

were two minima, in 2001 and 2005 (Fig. 1). As a consequence, the spectral type of the nucleus changed from a Sy1.5 in the maximum activity state to a Sy1.8 in the minimum state. The line profiles were strongly variable, showing changes of the blue and red asymmetry. The Hα, Hg and HeII4686 fluxes were well correlated with the Hβ (correlation coeficient $\sim$0.95). There was a good linear relationship between the emission line and continuum flux variations when the continuum flux F_c was $\leq 7 \times 10^{-14}$ erg cm^{-2} s^{-1} Å^{-1}. When F_c was large $\geq 7 \times 10^{-14}$ erg cm^{-2} s $^{-1}$ Å^{-1} the line fluxes either were weakly correlated, or simply did not correlate at all with the continuum flux. We considered three characteristic periods during which the Hα and Hβ profiles were similar: 1996–1999, 2000–2001 and 2002–2006. The line to continuum flux ratios were different; in particular during the first period (1996–1999), the lines were not correlated with the continuum and saturated at high fluxes. In the second and third period (2000–2006), where the continuum flux was small, the Hα and Hβ fluxes were well correlated to the continuum flux, meaning that the ionizing continuum was a good extrapolation of the optical continuum. The CCFs are often

asymmetrical and the time lags between the lines and the continuum are badly defined indicating the presence of a complex BLR, with dimensions from 1 to 50 light-days.

We found an excess of line emission with respect to a pure photoionization model during the whole monitoring period. This result could imply either the presence of a non-radiatively heated region, or an ionizing to optical flux ratio larger than expected for a typical AGN spectrum.

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