

Optical Spectroscopy of GK Persei during outburst and quiescence

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Abstract. We present here the optical spectra of GK Persei obtained during 1995 – 2001. This period includes two dwarf-nova outbursts and the quiescence phases.

INTRODUCTION

The old nova GK Persei is well-known for exhibiting dwarf-nova outbursts since 1948. GK Per has a quasiperiodic outburst interval ranging from 900 to 1340 days. Some of the latest events occurred in 1996, 1999 and 2002, taking about a month to reach maximum at mean magnitude of 10.3 – 10.5 from its quiescent level of 13.5 mag. Thermally unstable disc models have generally been used to explain the outburst photometric properties of GK Per [4]. However, neither standard steady state nor non-steady state models can satisfactorily explain the uv spectra of GK Per at minimum or maximum [5]. The disc-heating mechanism is thus still elusive.

In a previous study [1], we had deduced the parameters of the secondary star, the white dwarf and the accretion disc. One conclusion was that the accretion disc is smaller at quiescence than during outburst. We have continued monitoring GK Per and here we present some spectra obtained during the various phases of its activity.

OBSERVATIONS

CCD spectra were obtained during 1995 – 2001 using the Boller & Chivens and OMR spectrographs at the 2.3m Vainu Bappu Telescope and cover the wavelength range 4400 – 8000 Å, with dispersions of 2.6 or 5.3 Å/pixel. FeAr and HeNe lamps were used for wavelength calibration and different standard stars were used for flux calibration. However, the spectra presented here are on a relative flux scale.

DESCRIPTION OF THE SPECTRA

The spectrum of GK Per is a composite of the secondary absorption and accretion disc emission components. The secondary contributes about 40% of the light during quiescence [1].

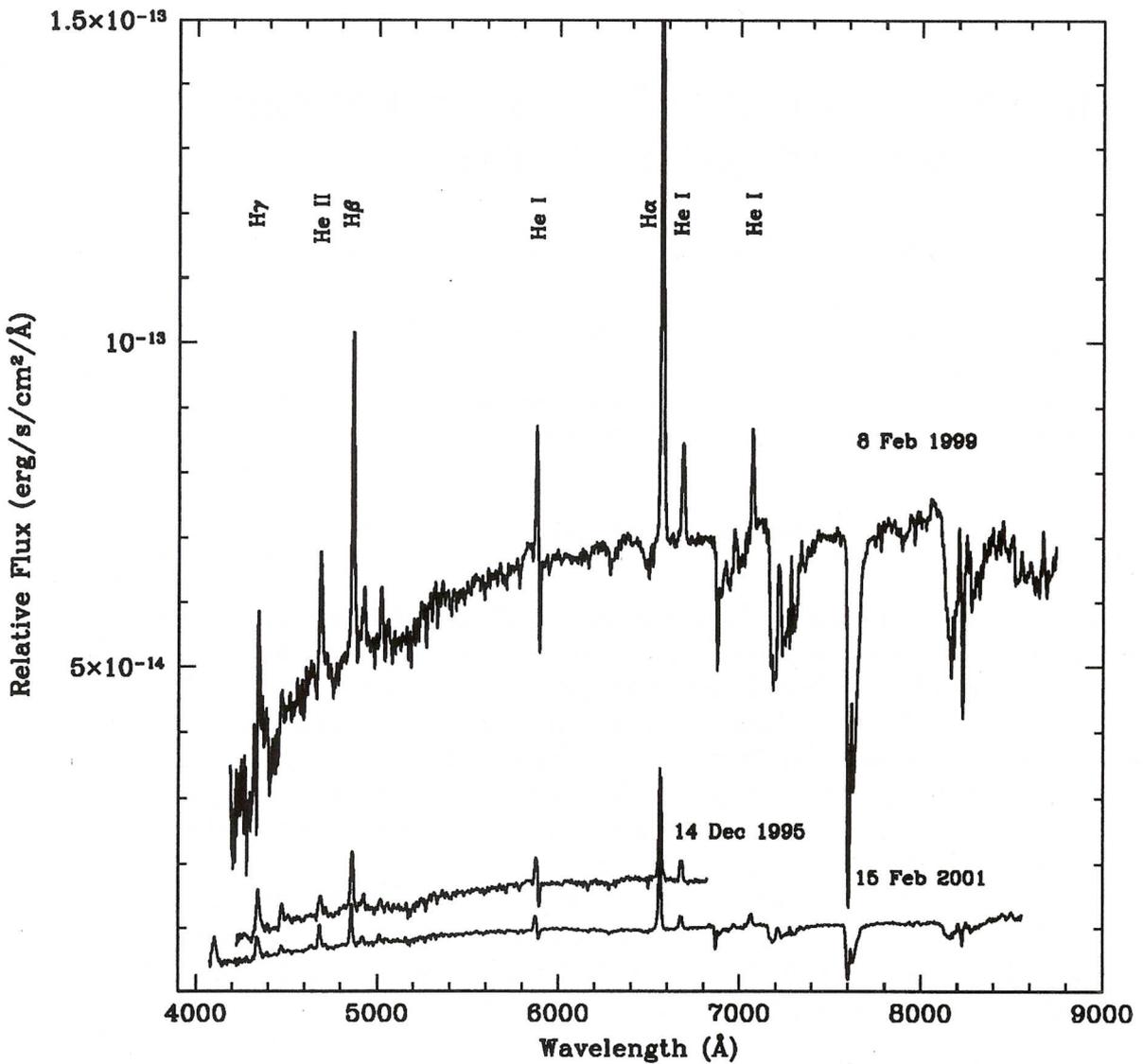


FIGURE 1. Spectra of GK Persei during quiescence.

Spectra at quiescence

- 14 Dec 1995 : An interesting feature of this spectrum is that the $H\alpha$ and He I 6678 lines are split. This is probably the first time that the $H\alpha$ line in GK Per has been observed to show some structure.
- 8 Feb 1999 : GK Per rising towards outburst, which occurred in late March 1999. The brightness increase is reflected in the higher continuum level. The equivalent widths of the Balmer lines have also increased and are the highest among these quiescent spectra.

- 15 Feb 2001 : Spectrum similar to Dec 1995 spectrum. However, the He I lines show a flat-topped profile with some structure.

The observed $H\alpha/H\beta$ ratios are in the range 1.7 to 2.2, similar to that observed in earlier spectra [3]. The departure from the standard Case A or B recombination has been attributed by them to a second emission line region which is the source of the Balmer radiation.

It is seen that the equivalent widths of various helium lines lies in the range of 3 to 7 Å at all epochs. The Balmer lines, however, show considerable variation in their equivalent widths with time. The $H\alpha$ equivalent width is between 16 to 27 Å. The equivalent width of $H\beta$ is 11 to 16 Å. Thus, as has been observed earlier (e.g., [2]), GK Per shows activity in terms of varying emission line strengths even at quiescence.

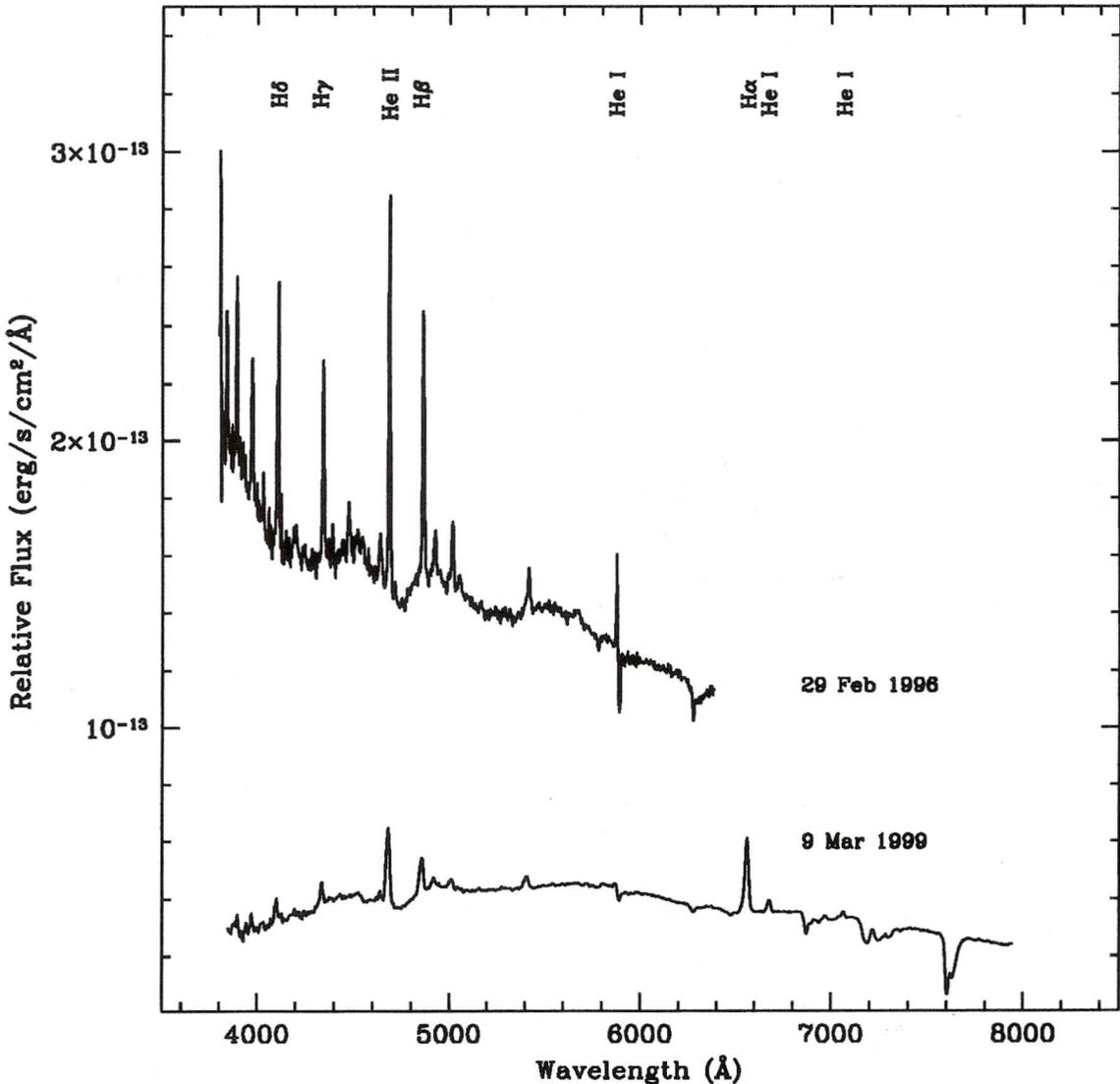


FIGURE 2. Spectra of GK Persei during or rising towards outburst.

Spectra at outburst

We have spectra for the previous two outbursts of GK Per.

- 29 Feb 1996 : GK Per had a minor outburst from late February to April 1996. The rise in the flux levels at the shorter wavelengths and the slope of the continuum clearly indicates that the accretion disc has brightened up.
- 9 Mar 1999 : GK Per had a small outburst starting late February 1999. Since GK Per takes about a month to reach its maximum, the outburst nature is not readily apparent in this spectrum. However, a comparison with the quiescent spectra shows the increased level of the continuum. The $H\alpha/H\beta$ ratio is 2.2. The He II 4686 Å feature is considerably stronger than $H\beta$ during outbursts ; in quiescence it has an equivalent width only about 50% of that of $H\beta$.

CONCLUDING REMARKS

The emission lines show structure which varies from epoch to epoch. This, and the Balmer decrements, can tell us about the nature and location of the emission regions. The interesting structures shown by various lines needs to be investigated. These spectra will be compared with model spectra in a detailed study in order to better understand the quiescent and outburst nature of GK Per. Such spectroscopic studies have the potential to refine the models of GK Persei's outburst.

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