α Eri: rotational distortion, stellar and circumstellar activity

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We explore the geometrical distortion and the stellar and circumstellar activity of α~Eri (HD 10144), the brightest Be star in the sky. We present a thorough discussion of the fundamental parameters of the object for an independent determination of its rotational distortion. We used stellar atmosphere models and evolutionary tracks calculated for fast rotating early-type stars. If the star is a rigid rotator, its angular velocity rate is $\Omega/\Omega_c \simeq$ 0.8, so that its rotational distortion is smaller than the one inferred from recent interferometric measurements. We then discuss the stellar surface activity using high resolution and high S/N spectroscopic observations of He\,{\sc i} and Mg\,{\sc ii} lines, which concern a period of Hα line emission decline. The variations in the He\,{\sc i} lines are interpreted as due to non-radial pulsations. Time series analysis of variations was performed with the {\sc cleanest} algorithm, which enabled us to detect the following frequencies: 0.49, 0.76, 1.27 and 1.72 c/d and pulsation degrees $\ell \sim (3-4)$ for ν = 0.76 c/d; $\ell \sim (2-3)$ for ν = 1.27 c/d and $\ell \sim (3-4)$ for ν = 1.72 c/d. The study of the absolute deviation of the He\,{\sc i} $\lambda $6678 \AA\ spectral line revealed mass ejection between 1997 and 1998. We conclude that the lowest frequency found, $\nu =$ 0.49 c/d, is due to the circumstellar environment, which is present even at epochs of low emission in the wings of He\,{\sc i} $\lambda $6678 \AA\ and Mg\,{\sc ii} λ4481 \AA\ line profiles, as well as during nearly normal aspects of the Hα line.
This suggests that there may be matter around the star affecting some spectral regions, even though the object displays a B-normal like phase. The long-term changes of the Hα line emission in α~Eri are studied. We pay much attention to the Hα line emission at the epoch of interferometric observations. The Hα line emission is modeled and interpreted in terms of varying structures of the circumstellar disc. We conclude that during the epoch of interferometric measurements there was enough circumstellar matter near the star to produce $\lambda 2.2\mu$m flux excess, which could account for the overestimated stellar equatorial angular diameter. From the study of the latest \bbe\ phase transition of α~Eri we concluded that the Hα line emission formation regions underwent changes so that: a) the low Hα emission phases are characterized by extended emission zones in the circumstellar disc and a steep outward matter density decline; b) during the strong Hα emission phases the emitting regions are less extended and have a constant density distribution. The long-term variations of the Hα line in α~Eri seem to have a 14-15 year cyclic \bbe phase transition. The disc formation time scales, interpreted as the periods during which the Hα line emission increases from zero to its maximum, agree with the viscous decretion model. On the other hand, the time required for the disc dissipation ranges from 6 to 12 years which questions the viscous disc model.

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