Multiple short-lived stellar prominences on O stars: The O6.5I(n)fp star lambda Cephei

N.P. Sudnik (1,2), H.F. Henrichs (1)

(1) University of Amsterdam, (2) Saint-Petersburg State University

Most O-type stars and many B stars show unexplained cyclical variability in their spectral lines, i.e., modulation on the rotational timescale, but not strictly periodic. The variability occurs in the so-called discrete absorption components (DACs) that accelerate through the UV-wind line profiles and also in many optical lines. For such OB stars no dipolar magnetic fields have been detected with upper limits of ~ 300 G.
We investigate whether multiple magnetic loops on the surface rather than non-radial pulsations (NRPs) or a dipolar magnetic field can explain the observed cyclical UV and optical spectral line variability.
We present time-resolved, high-resolution optical spectroscopy of the O6.5I(n)fp star lambda Cephei. We apply a simplified phenomenological model in which multiple spherical blobs attached to the surface represent magnetic-loop structures, which we call stellar prominences, by analogy with solar prominences. We compare the calculated line profiles as a function of rotational phase, adopting a rotation period of 4.1 d, with observed relative changes in subsequent quotient spectra.
We identify many periodicities in spectral lines, almost none of which is stable over timescales from months to years. We show that the relative changes in various optical absorption and emission lines are often very similar. Our proposed model applied to the He II 4686 line can typically be fitted with 2--5 equatorial blobs with lifetimes between ~ 1 and 24 h.
Given the irregular timescales involved, we propose that the azimuthal distribution of DACs correspond to the locations of stellar prominences attached to the surface. This could explain the observed variability of optical and UV lines, and put constraints on the strength and lifetime of these structures, which can be compared with recent theoretical predictions, in which bright magnetic surface spots are formed by the action of the subsurface convection zone.

Reference: A&A (in press)
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1606.00404

Comments: Accepted May 02, 2016, 30 pages, 48 figures

Email: h.f.henrichs@uva.nl