Revisiting the Rigidly Rotating Magnetosphere model for Ïƒ Ori E - II. Magnetic Doppler imaging, arbitrary field RRM, and light variability

M. E. Oksala, O. Kochukhov, J. Krticka, R. H. D. Townsend, G. A. Wade, M. Prvak, Z. Mikulasek, J. Silvester, S. P. Owocki

Observatoire de Paris-Meudon, University of Delaware, Astronomical Insitute ASCR, Uppsala Univeristy, University of Wisconsin-Madison, RMC, Masaryk Univeristy, Queen's University

The initial success of the Rigidly Rotating Magnetosphere (RRM) model application to the B2Vp star sigma Ori E by Townsend, Owocki & Groote (2005) triggered a renewed era of observational monitoring of this archetypal object. We utilize high-resolution spectropolarimetry and the magnetic Doppler imaging (MDI) technique to simultaneously determine the magnetic configuration, which is predominately dipolar, with a polar strength Bd = 7.3-7.8 kG and a smaller non-axisymmetric quadrupolar contribution, as well as the surface distribution of abundance of He, Fe, C, and Si. We describe a revised RRM model that now accepts an arbitrary surface magnetic field configuration, with the field topology from the MDI models used as input. The resulting synthetic Ha emission and broadband photometric observations generally agree with observations, however, several features are poorly fit. To explore the possibility of a photospheric contribution to the observed photometric variability, the MDI abundance maps were used to compute a synthetic photospheric light curve to determine the effect of the surface inhomogeneities. Including the computed photospheric brightness modulation fails to improve the agreement between the observed and computed photometry. We conclude that the discrepancies cannot be explained as an effect of inhomogeneous surface abundance. Analysis of the UV light variability shows good agreement between observed variability and computed light curves, supporting the accuracy of the photospheric light variation calculation. We thus conclude that significant additional physics is necessary for the RRM model to acceptably reproduce observations of not only sigma Ori E, but also other similar stars with significant stellar wind-magnetic field interactions.

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Email: meo@udel.edu