Polarimetric modeling of corotating interaction regions (CIRs) threading massive-star winds

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Context. Massive star winds are complex radiation-hydrodynamic (sometimes magnetohydrodynamic) outflows that are propelled by their enormously strong luminosities. The winds are often found to be structured and variable, but can also display periodic or quasi-periodic behavior in a variety of wind diagnostics.
Aims. The regular variations observed in putatively single stars, especially in UV wind lines, have often been attributed to corotating interaction regions (CIRs) like those seen in the solar wind. We present light curves for variable polarization from winds with CIR structures.
Methods. We develop a model for a time-independent CIR based on a kinematical description. Assuming optically thin electron scattering, we explore the range of polarimetric light curves that result as the curvature, latitude, and number of CIRs are varied. Results. We find that a diverse array of variable polarizations result from an exploration of cases. The net polarization from an unresolved source is weighted more toward the inner radii of the wind. Given that most massive stars have relatively fast winds compared to their rotation speeds, CIRs tend to be conical at inner radii, transitioning to a spiral shape at a few to several stellar radii in the wind.
Conclusions. Winds with a single CIR structure lead to easily identifiable polarization signatures. By contrast allowing for multiple CIRs, all emerging from a range of azimuth and latitude positions at the star, can yield complex polarimetric behavior. Although our model is based on some simplifying assumptions, it produces qualitative behavior that we expect to be robust, and this has allowed us to explore a wide range of CIR configurations that will prove useful for interpreting polarimetric data.

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Comments:

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