Revealing the structure of the outer disks of Be stars

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The structure of the inner parts of Be star disks (~< 20 stellar radii) is well explained by the viscous decretion disk (VDD) model, which is able to reproduce the observable properties of most of the objects studied so far. The outer parts, on the other hand, are not observationally well-explored, as they are observable only at radio wavelengths. A steepening of the spectral slope somewhere between infrared and radio wavelengths was reported for several Be stars that were previously detected in the radio, but a convincing physical explanation for this trend has not yet been provided. We test the VDD model predictions for the extended parts of a sample of six Be disks that have been observed in the radio to address the question of whether the observed turndown in the spectral energy distribution (SED) can be explained in the framework of the VDD model, including recent theoretical development for truncated Be disks in binary systems. We combine new multi-wavelength radio observations from the Karl.~G.~Jansky Very Large Array (JVLA) and Atacama Pathfinder Experiment (APEX) with previously published radio data and archival SED measurements at ultraviolet, visual, and infrared wavelengths. The density structure of the disks, including their outer parts, is constrained by radiative transfer modeling of the observed spectrum using VDD model predictions. In the VDD model we include the presumed effects of possible tidal influence from faint binary companions. For 5 out of 6 studied stars, the observed SED shows strong signs of SED turndown between far-IR and radio wavelengths. A VDD model that extends to large distances closely reproduces the observed SEDs up to far IR wavelengths, but fails to reproduce the radio SED. Using a truncated VDD model improves the fit, leading to a successful explanation of the SED turndown observed for the stars in our sample. The slope of the observed SEDs in the radio is however not well reproduced by disks that are simply cut off at a certain distance. Rather, some matter seems to extend beyond the truncation radius, where it still contributes to the observed SEDs, making the spectral slope in the radio shallower. This finding is in agreement with our current understanding of binary truncation from hydrodynamical simulations, in which the disk does extend past the truncation radius. Therefore, the most probable cause for the SED turndown is the presence of binary companions that remain undetected for most of our sources.

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