Can single O stars produce non-thermal radio emission?

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We present a model for the non-thermal radio emission from presumably single O stars, in terms of synchrotron emission from relativistic electrons accelerated in wind-embedded shocks. These shocks are associated with an unstable, chaotic wind. The main improvement with respect to earlier models is the inclusion of the radial dependence of the shock velocity jump and compression ratio, based on one-dimensional time-dependent hydrodynamical simulations. The decrease of the velocity jump and the compression ratio as a function of radius produces a rapidly decreasing synchrotron emissivity. This effectively prohibits the models from reproducing the spectral shape of the observed non-thermal radio emission. We investigate a number of ``escape routes" by which the hydrodynamical predictions might be reconciled with the radio observations. We find that the observed spectral shape can be reproduced by a slower decline of the compression ratio and the velocity jump, by the re-acceleration of electrons in many shocks or by adopting a lower mass-loss rate. However, none of these escape routes are physically plausible. In particular, re-acceleration by feeding an electron distribution through a number of shocks, is in contradiction with current hydrodynamical simulations. These hydrodynamical simulations have their limitations, most notably the use of one-dimensionality. At present, it is not feasible to perform two-dimensional simulations of the wind out to the distances required for synchrotron-emission models. Based on the current hydrodynamic models, we suspect that the observed non-thermal radio emission from O stars cannot be explained by wind-embedded shocks associated with the instability of the line-driving mechanism. The most likely alternative mechanism is synchrotron emission from colliding winds. That would imply that all O stars with non-thermal radio emission should be members of binary or multiple systems.

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