N28a The common envelope evolution beyond the dynamic in-spiral: homologous dynamics and dust formation

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We study the asymptotic behaviour of the common envelope expansion after the dynamic in-spiral terminates. We use the SPH code PHANTOM to simulate a 0.88 $M_{\odot}$, 83 $R_{\odot}$ RGB primary and a 0.6 $M_{\odot}$ companion system, then we follow the ejecta expansion for $\simeq 50$ yr, way beyond the termination of the dynamic in-spiral. We show that, as time passes, the envelope's radial velocities dominate over the tangential ones, hence allowing us to apply an homologous expansion kinematic model to the ejecta. It takes $\simeq 5000$ days ($\simeq 14$ years) for the bulk of the ejecta to achieve the homologously expanding regime. We observe that the complex distribution generated by the dynamic in-spiral evolves into a more ordered, shell-like shaped one in the asymptotic regime. In a novel approach, we apply the dust formation model of Nozawa et al. on the expanding ejecta. We show that dust forms efficiently in the window between $\simeq 300$ days (the end of the dynamic in-spiral) and $\simeq 5000$ days. The dust forms in two separate populations; an outer one in the material ejected during the first few orbits of the companion inside the primary's envelope and an inner one in the rest of the ejected material. The inner dust population dominates the grain size distribution at the end of the simulation. We are able to fit the grain size distribution at the end of the simulation with a double power law. The slope of the power law for smaller grains is flatter than that for larger grains, but the power law exponents are different from the classical values determined for the interstellar medium. We also estimate that the contribution to cosmic dust by common envelope events is not negligible and comparable to that of novae and supernovae.