Recombination driven transients

Transients 2022, problem set I – due 2022 Oct 24

In this problem set, we will use Arnett's semi-analytic "one-zone" approach to lightcurves on other types of sources. For this, you will need an implementation of the code. You are welcome to try to construct this yourself (if so, I'd recommend starting with the description in the appendix of Arnett et al., `2017ApJ...846...33A`, then add recombination), but probably easier to start with my attempt at `https://github.com/mhvk/snlc/` (if you find any bugs, please do raise an issue, or, better still, make a pull request with a fix!).

With that code,

1. Check that you can reproduce some of the figures in Arnett et al., `2017ApJ...846...33A` and in Arnett's Supernova book. Specifically, hand in your figure, the code (snippet) that you used to create it, and discuss the extent to which the results match (e.g., properties at maximum, rise and decay times, etc.)

2. See if you can reproduce expected lightcurves for at least 2 other types of transients. Here, for each one, describe the physics that is important for this transient, make a figure with a model lightcurve, show the code changes used (if you are using my code, ideally with a PR to my repository), and discuss how it compares with the literature results.

   You can pick your own favourite but suggestions are

   - Luminous Red Novae due to stellar merges, Ivanova et al. `2013Sci...339..433I`, their Fig. S4 (similar theory, though from different source).
   - Ultraluminous Supernovae, Kasen & Bildsten `2010ApJ...717..245K`, their Fig. 2 (very similar theoretical framework).
   - NS mergers, Kulkarni `2005astro.ph.10256K` (nice independent derivation of Arnett-like structure).
   - Interaction with CSM, Margalit `2022ApJ...933..238M` (derivation seems highly related).
   - Fast blue optical transient, Yao et al. `2022ApJ...934..104Y` (they don't present model, so goal here is to try to reproduce the observed lightcurve).