Observational Signature on the Tidal Disruption of Dark Stars by Massive Black Hole

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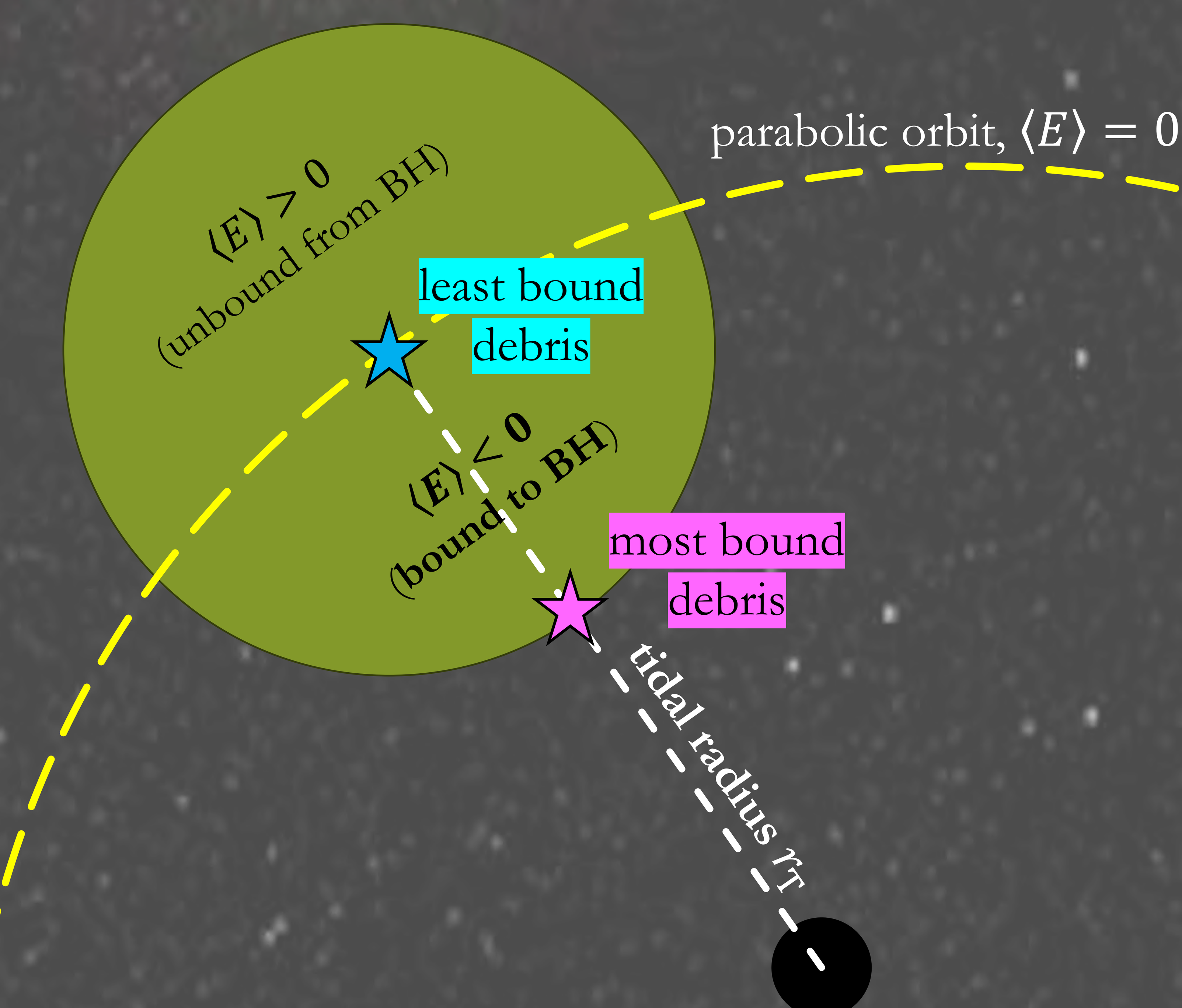
Introduction

Tidal Disruption Events (TDEs) are transients where a stellar object comes into close proximity of the galactic central massive black hole (BH), where the BH tidal force is sufficient to overcome the star's self-gravity.

Past work has only discussed on the disruption of various kinds of stars (main-sequence, giants, white dwarfs), but with the proliferation of literature in exploring the possibility of how the **stellar structure could be drastically different** when considering a large amount of **Dark-matter (DM) admixture**, we hope to extend the effort into TDEs.



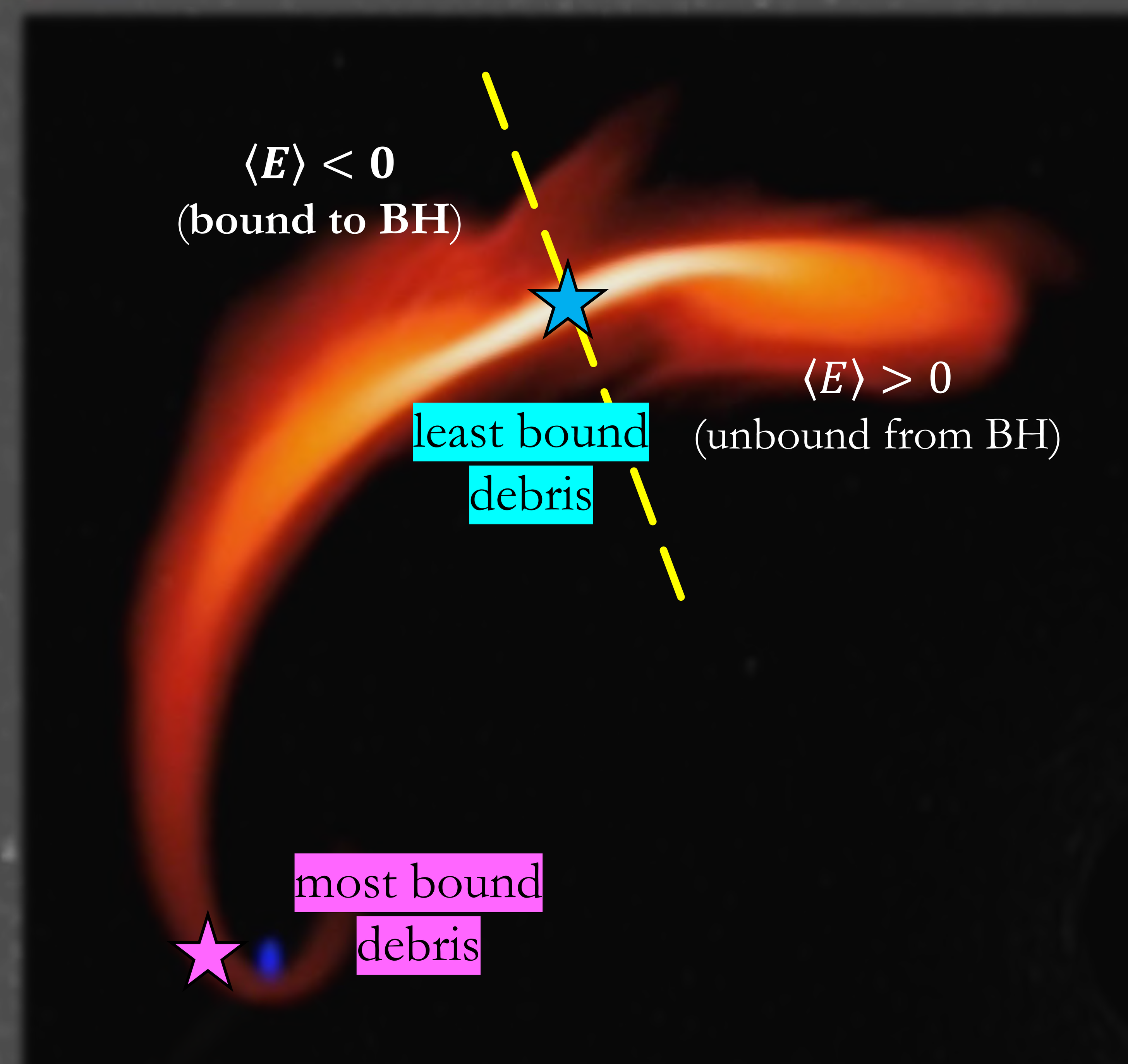
Tidal force elongates the star into a long **tidal debris stream** that eventually orbits back and feed the BH. Only the **mass with $\langle E\rangle \leq 0$** will eventually **return to the BH**, and the **mass return rate $\dot{M}_{\mathrm{return}}$** sensitively depends on the stellar **internal structure**.

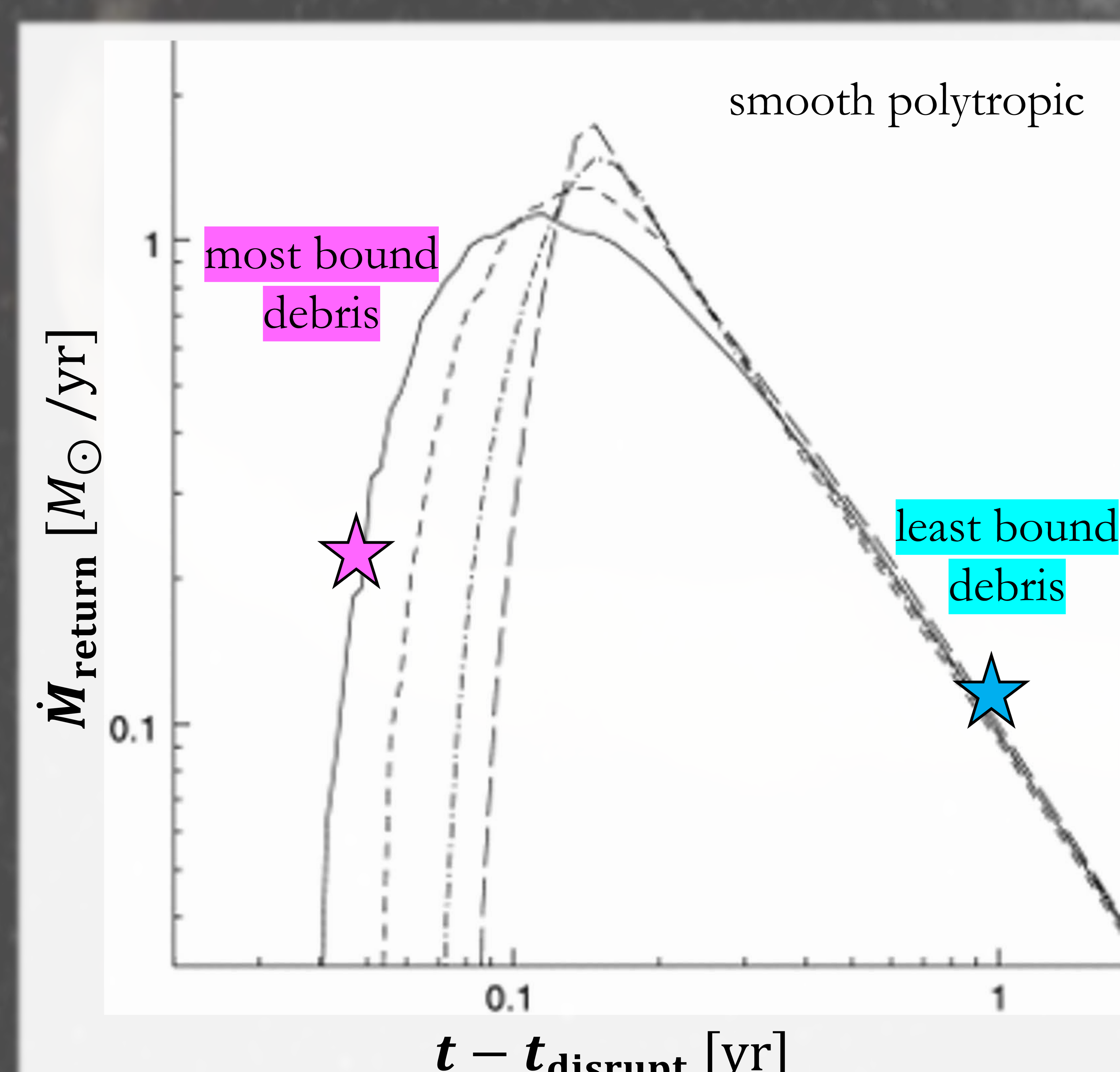
Scientific Question

How would the observed **TDE light curve differ** for:

(i) Highly **DM-admixed** stellar object,

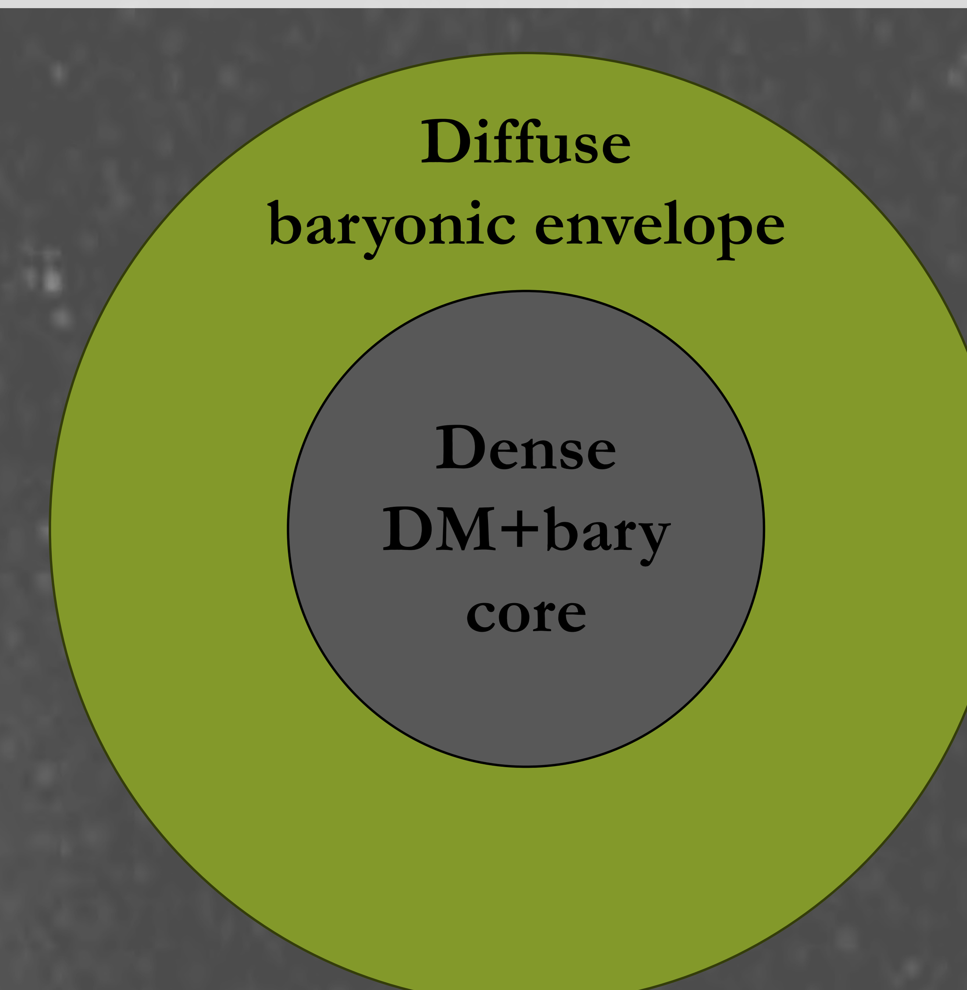
(ii) Common **Baryonic** star?





Setup

We consider a highly DM-admixed stellar object using **two-fluid model** assuming **self-interacting DM (SIDM)**. SIDM is able to dissipate their orbital energies and **sink to the centre of the star**, the enhanced gravitational contribution of the DM now creates an even deeper potential well that contracts the baryonic component.



The ***density profile*** of the diffuse baryonic envelope and the dense DM-admixed core is very similar to that of a ***giant***. For a total disruption, the star has to reach $r < r_T$ to disrupt even the dense core. We expect a **signature bump in the light curve $\dot{M}_{\mathrm{return}}(t)$ at the late phase evolution** as the huge discontinuity at the core-envelope boundary would give an **"unexpected" increase in mass** compared to the smoothly varying density in the polytropic model. The **luminous (baryonic) mass in the core is smaller than that of a giant**, so the bump would not be as large in our case.

Key References
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