# Titans of the Early Universe

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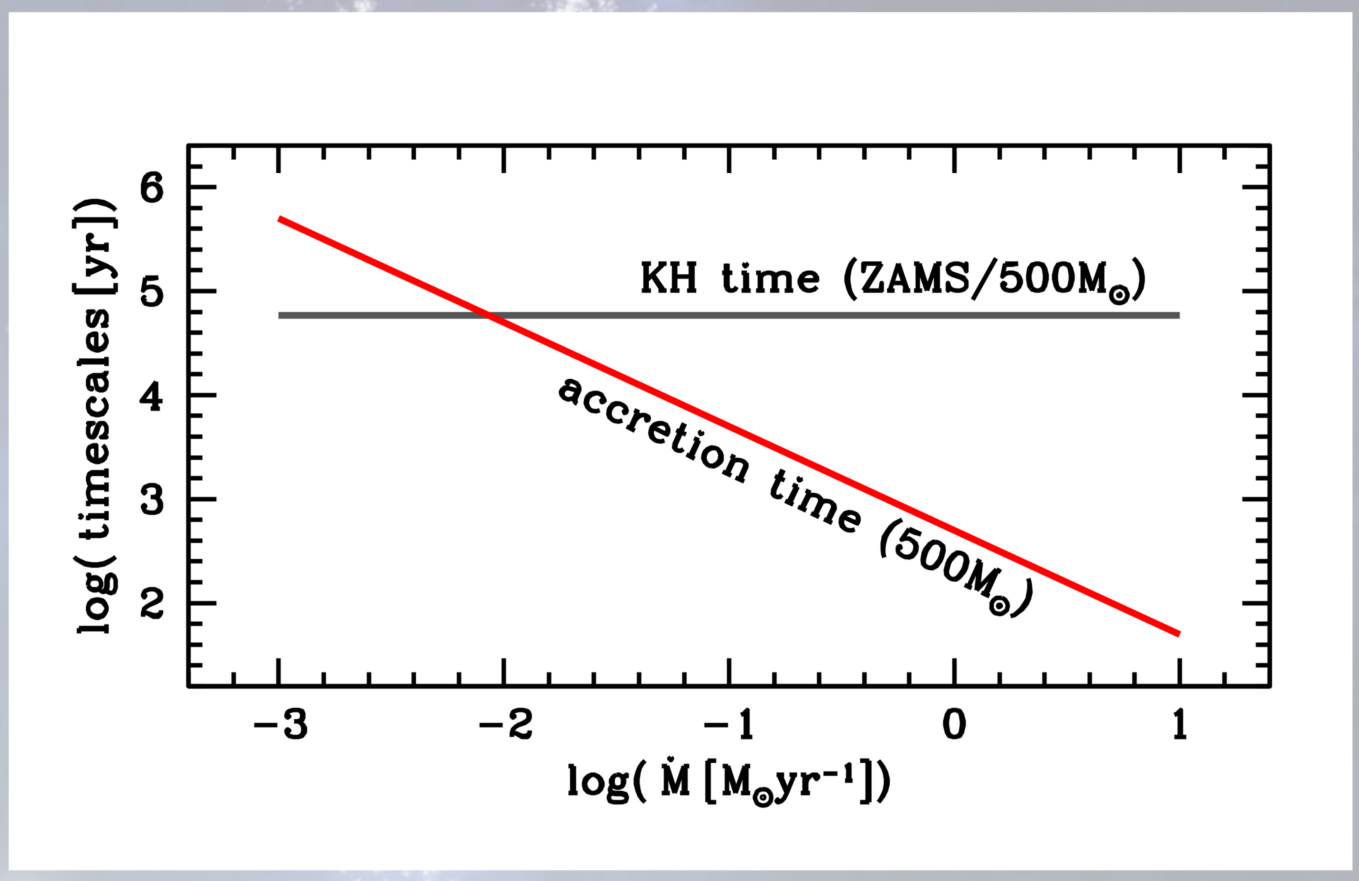
## Introduction

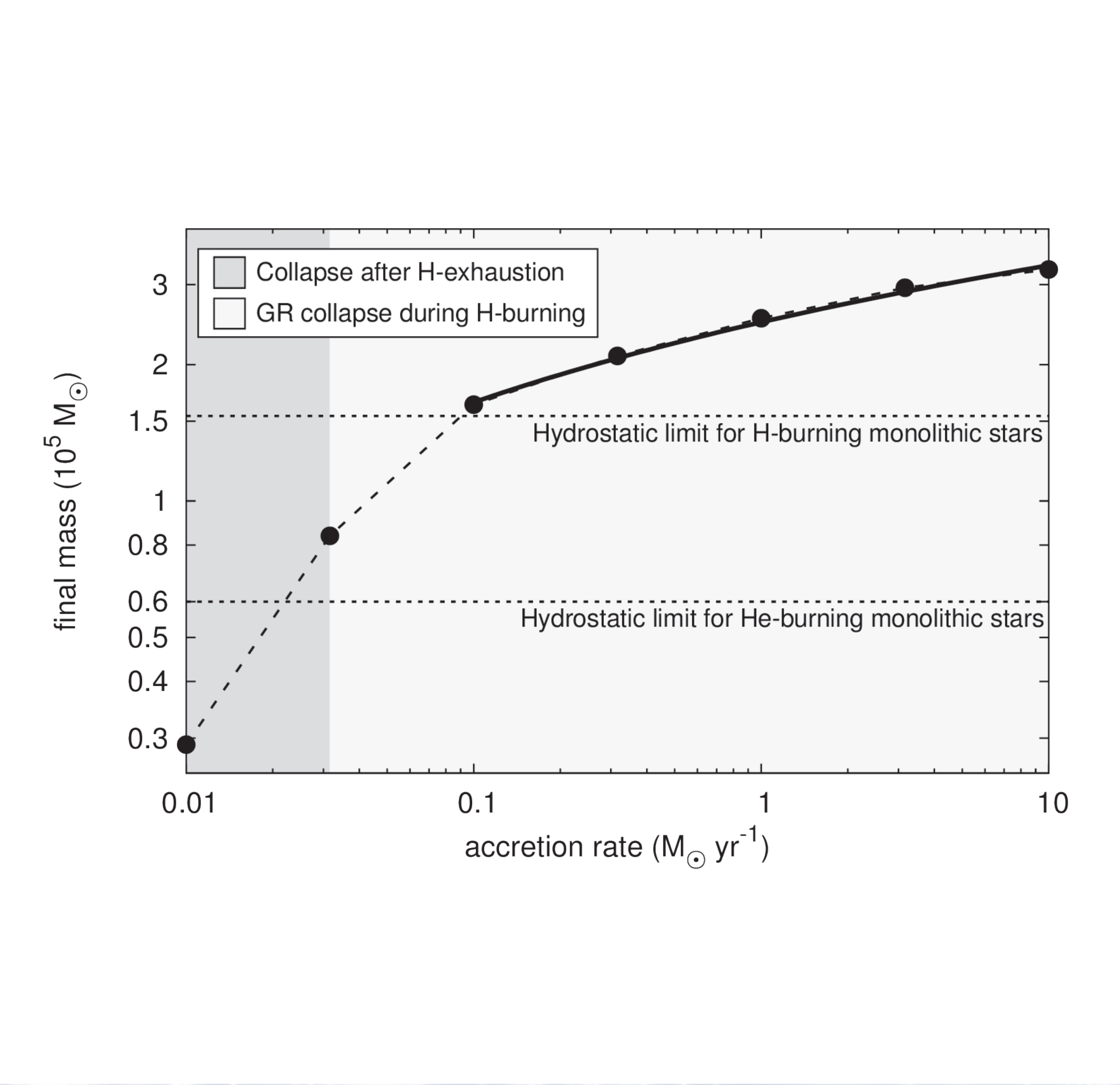
Supermassive primordial stars are now suspected to be the progenitors of the most massive quasars at z ~ 6. Previous studies could not self-consistently predict their final masses at the moment they collapse through the general relativistic (GR) instability (Chandrasekhar 1964). Here, we systematically examine the birth, evolution, and collapse of accreting supermassive stars using the stellar evolution code KEPLER.

## Methods

KEPLER includes post-Newtonian corrections to the stellar structure and an adaptive nuclear network, and is capable of following the hydrodynamic evolution of supermassive stars after they encounter the GR instability. Due to their formation under extremely rapid accretion, these stars are never thermally relaxed, invalidating previous approximate, polytropic treatments.




## Summary




We find that supermassive stars collapse after reaching ~150,000–330,000 solar masses for accretion rates in the expected regime (see figure), with central hydrogen fractions of order 50%. This can render them a spectacular site of rp-process nucleosynthesis—whether any products of this can escape remains unknown. Before collapse, pulsational mass loss may also lead to early chemical enrichment, but this too remains uncertain. We are now carrying out a concerted effort to determine the final fates of these astonishing objects (Woods, Heger, et al., ApJL, 2017; Haemmerlé, Woods, et al., submitted).