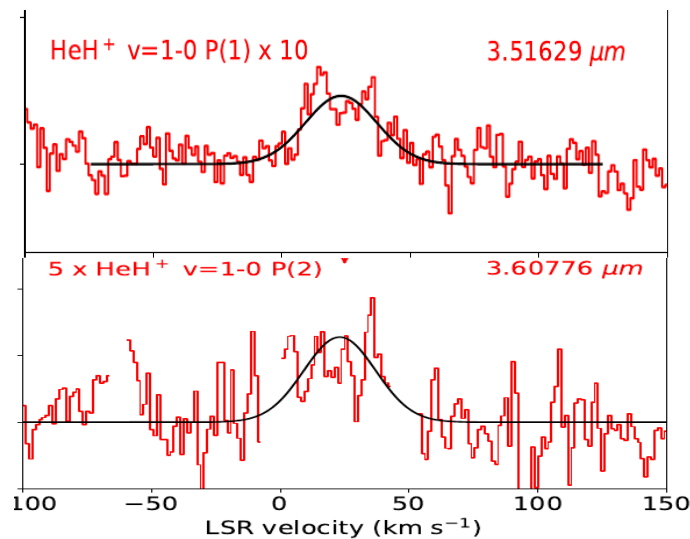


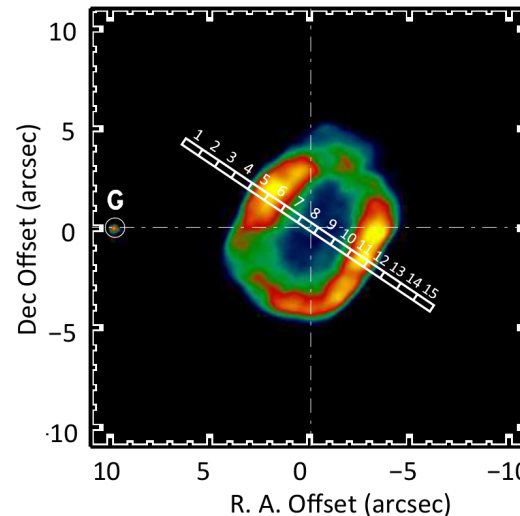
# ISHELL Detects Helium Hydride Ion ( $\text{HeH}^+$ ) in Planetary Nebula

$\text{HeH}^+$  is thought to be the first molecule formed after the Big Bang. Planetary Nebula observations test models of the formation and destruction of this molecule in the early Universe.

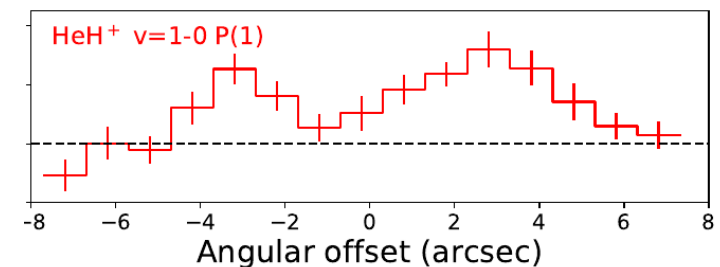
2  $\text{HeH}^+$  emission lines detected in PN NGC 7027, and >60 lines of other species, including the first detection of vibrational  $\text{CH}^+$  emission from space.



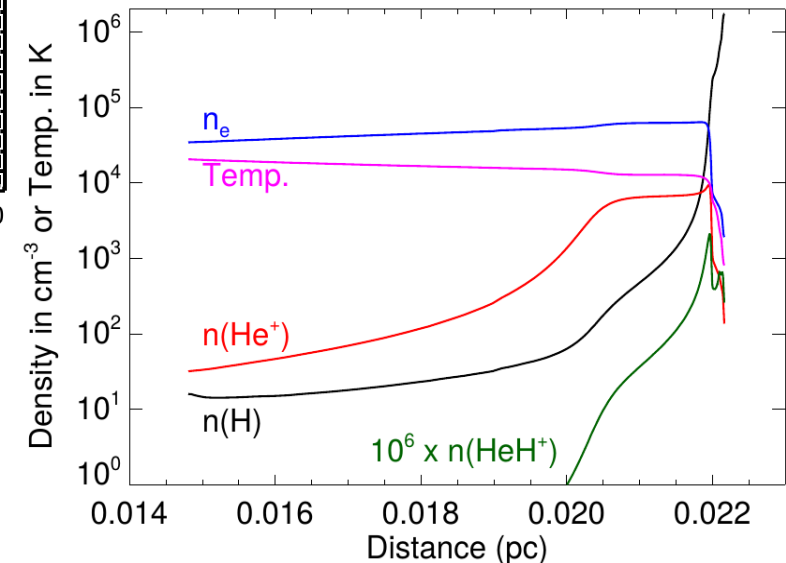
ISHELL broad band K guider image with 15" slit.



$\text{HeH}^+$  is present in thin shell



Modeled nebula



Models of  $\text{HeH}^+$  formation, destruction, and excitation are not entirely consistent (factor of 2-3) with the iSHELL vibrational and earlier SOFIA/GREAT rotational line observations (Guesten et al., 2019), suggesting an underestimated formation rate or deficiencies in the excitation rates.

Neufeld et al. 2020, *Astroph. Journal* (in press); <https://arxiv.org/pdf/2001.11344.pdf>