

The Molecular Content of Planetary Nebulae: The Next Level



[130.05]



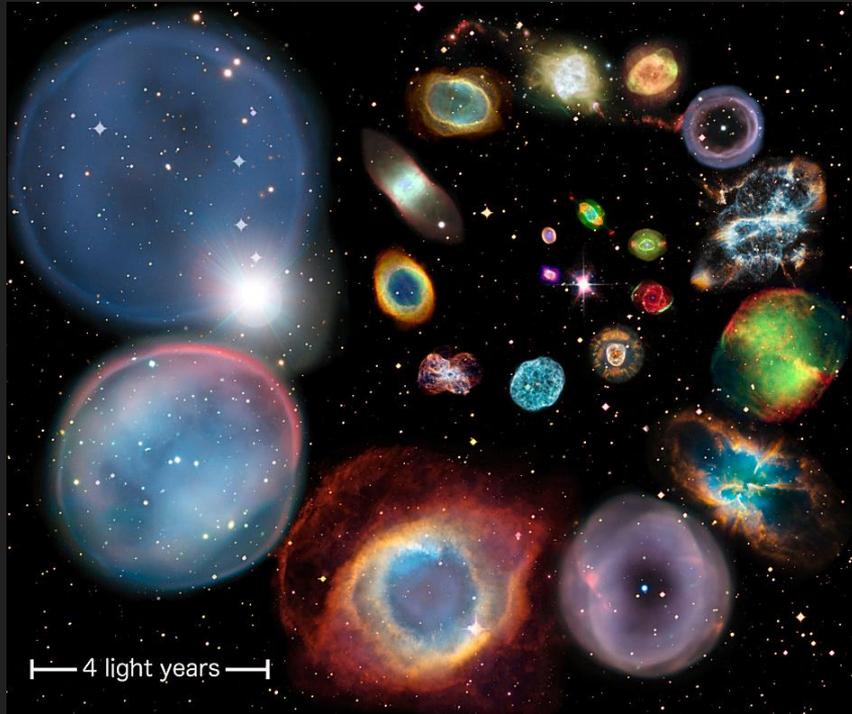
**Kate Gold¹, Ann Sinclair², Deborah Schmidt³, Lucy Ziurys⁴,
Sophie Bergstrom³**

¹Bryn Mawr College; krgold@brynmawr.edu, ²Swarthmore
College, ³Franklin & Marshall College, ⁴University of Arizona



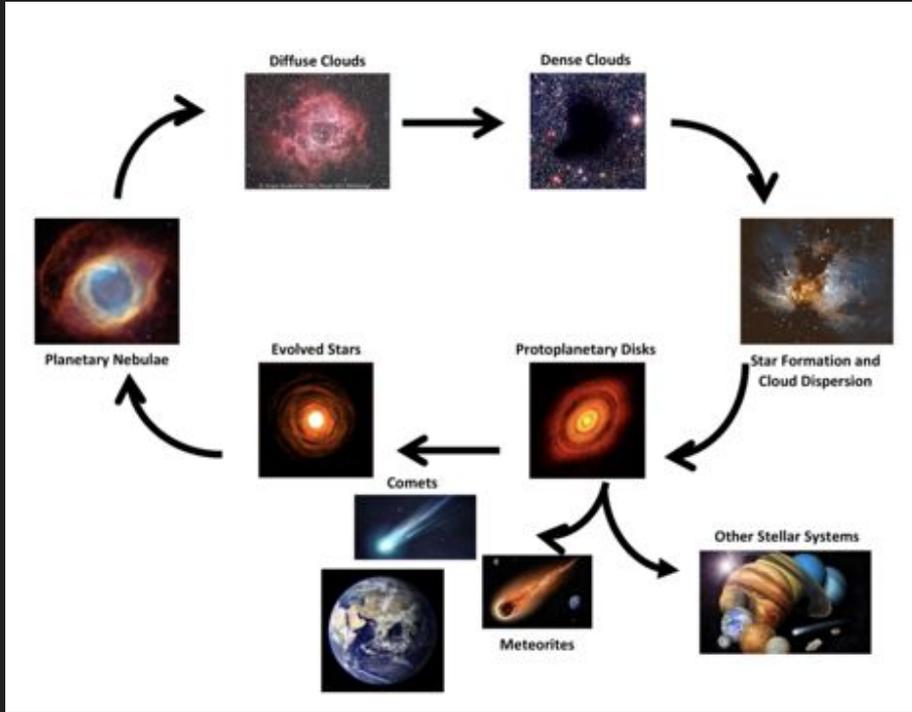
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Planetary Nebulae: The Last Gasps of Dying Stars



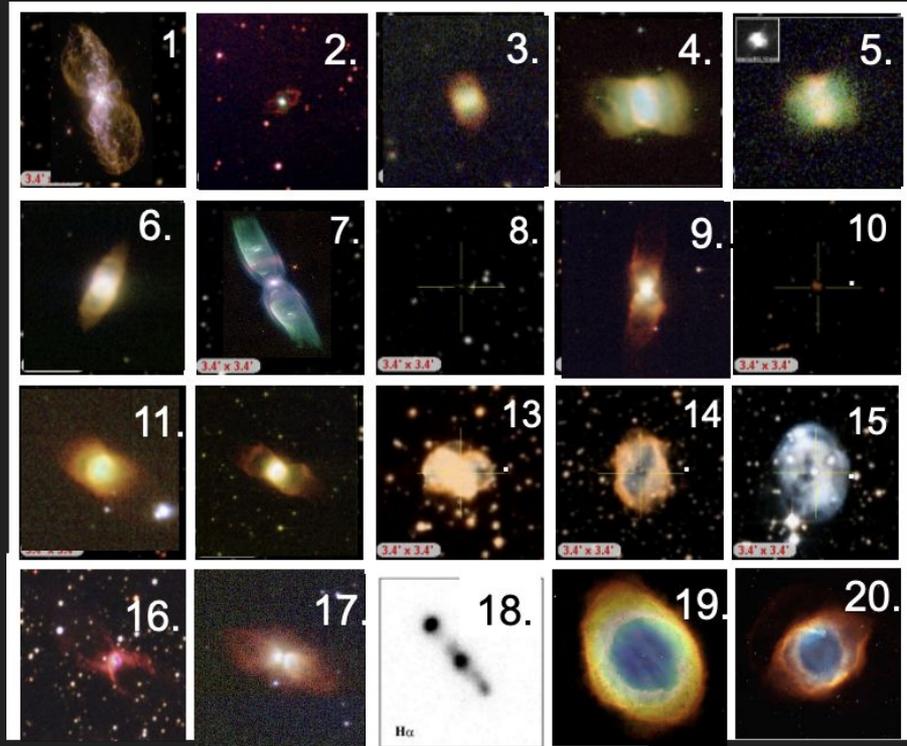
- Planetary nebulae (PNe) mark the final stage of Sun-like stars.
- The star's outer layers are ejected and flow away from the remnant core.
- Radiation from the hot core should destroy remnant molecules.

Molecular Recycling



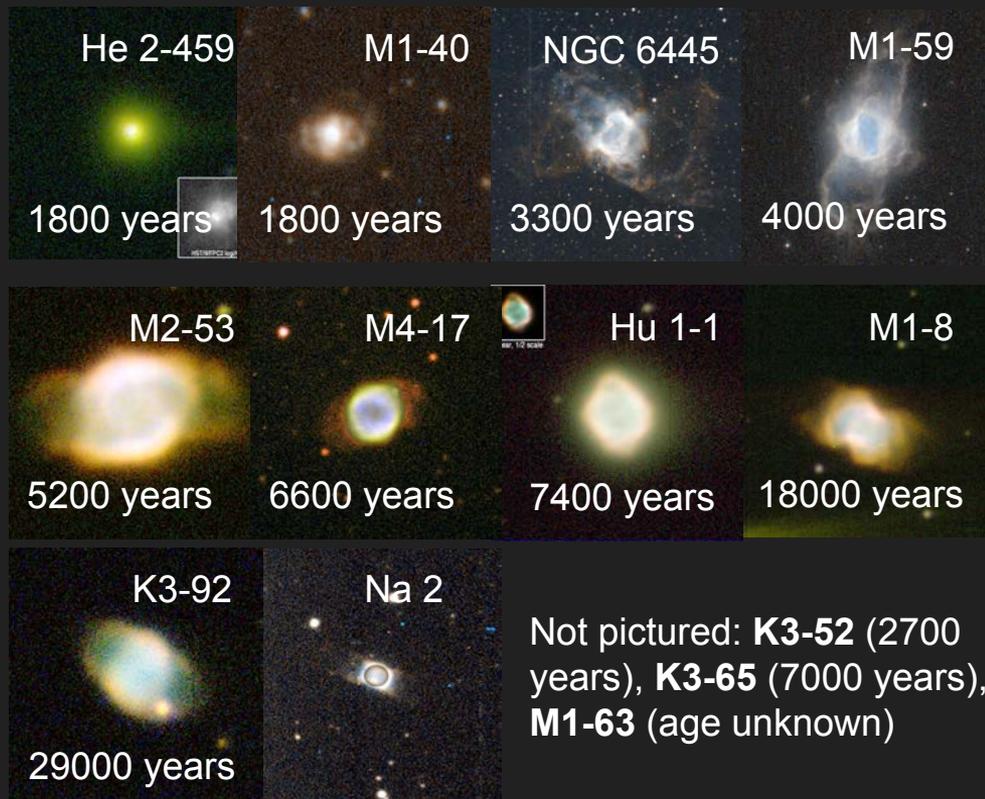
- PNe play an important role in the recycling of gas and dust in the ISM.
- Molecules that survive the PN stage can be used as building blocks for more complex molecules.

The Unexpected Hidden Carriers of Molecules: Planetary Nebulae

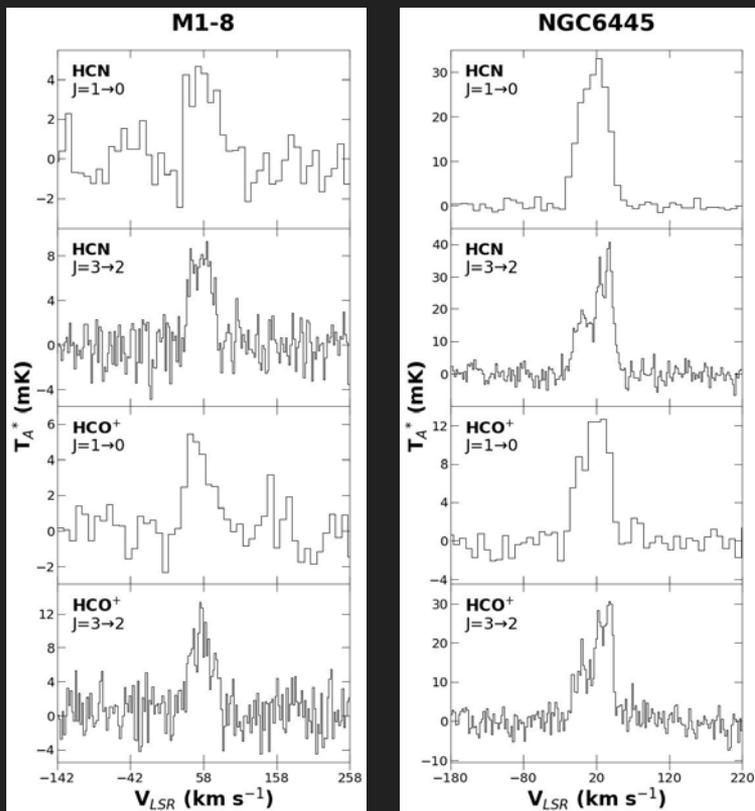


- Observations in 2016 of molecules in ~20 objects suggest PNe are **full** of molecules.
- Are these 20 special? Are all PNe molecule-rich?

Expanding Our Horizons: The Newest Molecular Study of PNe

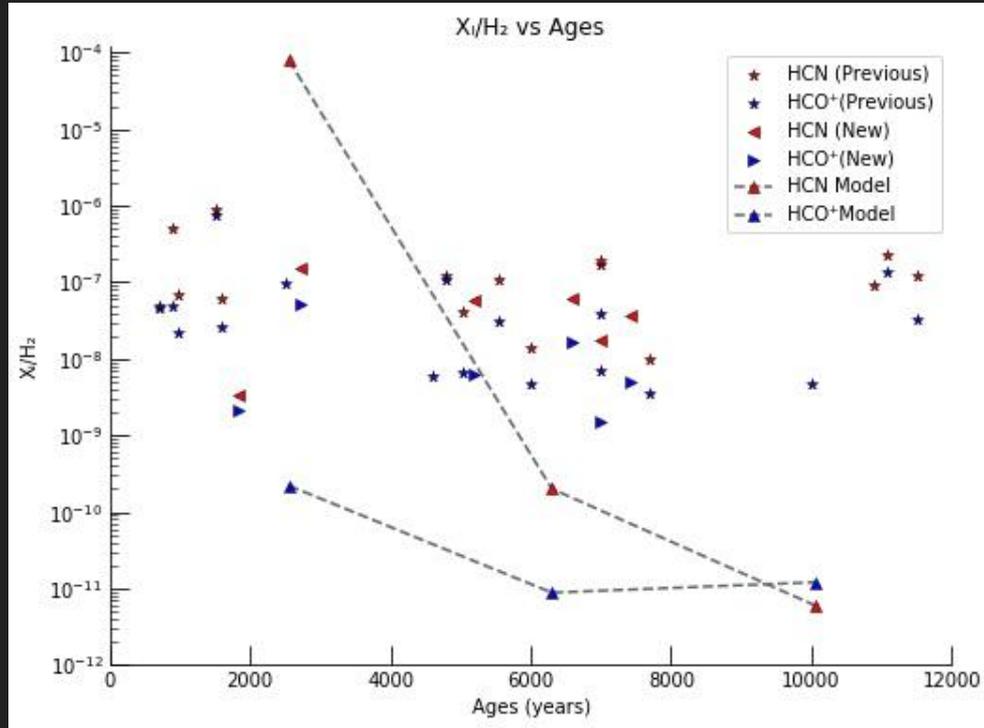


Survival Against All Odds



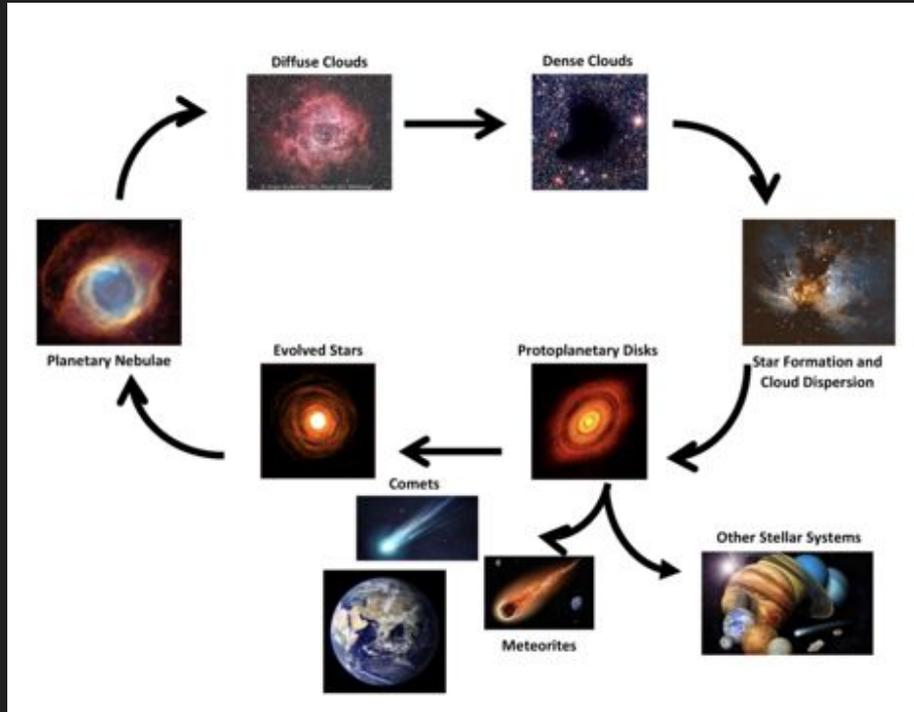
- HCN and/or HCO⁺ were **detected in 11 of the 13** of the nebulae surveyed.
- This brings the number of nebulae in which we've made molecular detections to **over 30!**
- Wherever we look for molecules, we find them.

Molecular Material Seeds the Diffuse ISM



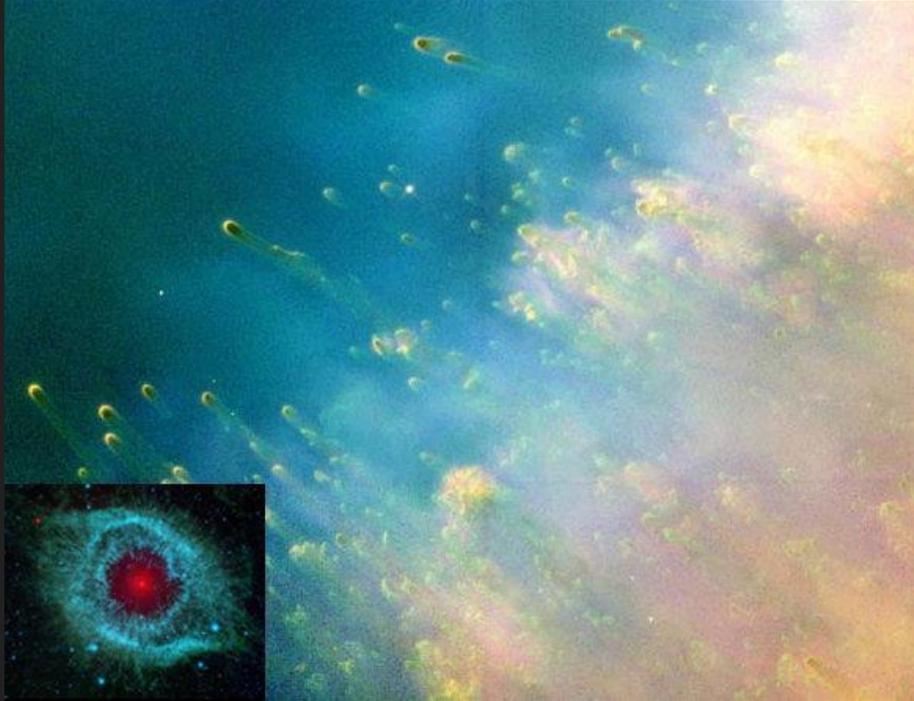
- Molecular abundance does not change significantly with nebular age.
- This completely contradicts model predictions.
- Molecules are capable of surviving the planetary nebula stage!

Molecular Material Seeds the Diffuse ISM



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Molecule Defenders: Cometary Knots in PNe

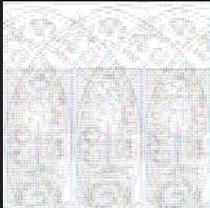


- Molecules may be shielded in dense clumps of gas and dust.
- These knots have been observed in several nearby planetary nebulae (e.g., the Helix Nebula).
- The clumps can disperse and seed the surrounding space with molecular material.

Summary

- Contrary to model predictions, molecular material survives the planetary nebula stage.
- These molecules disperse into the surrounding ISM from which new stellar systems form.
- This provides the building blocks with increasingly more complex species may be formed.

Acknowledgements



Contact us: Kate Gold
krgold@brynmawr.edu;
Deborah Schmidt
dschmidt@fandm.edu

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