

# Delivering prebiotic feedstocks with cometary impacts



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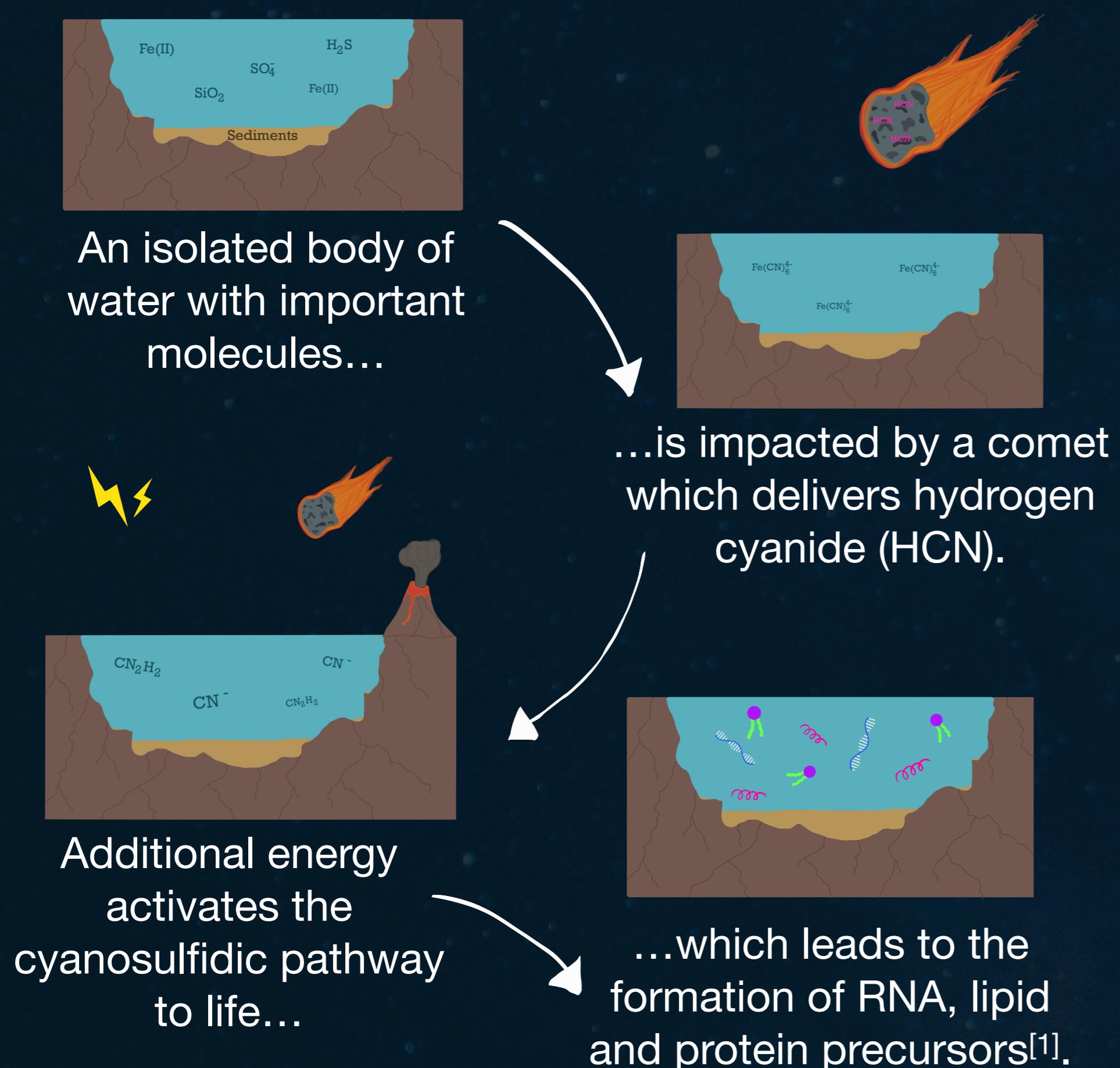
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## Delivery scenario

One particular scenario for the origins of life on the early Earth invokes cometary delivery in the following way<sup>[2]</sup>...



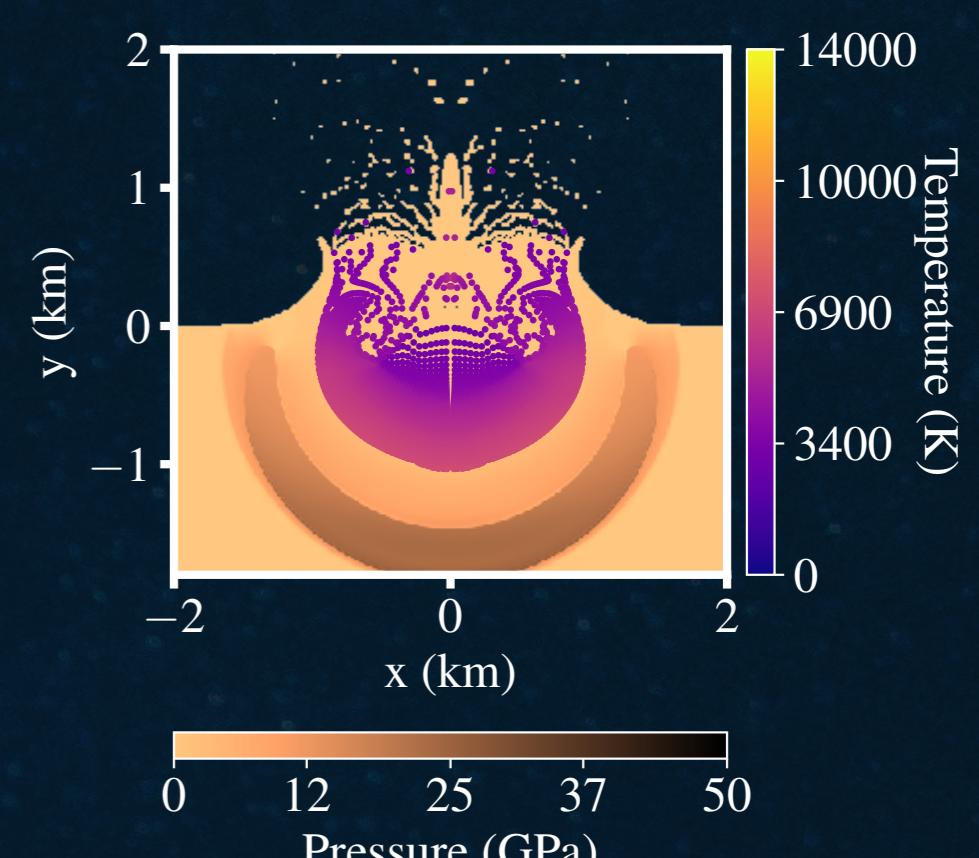
This work aims to determine how effective cometary impacts are at delivering HCN.

## Methods

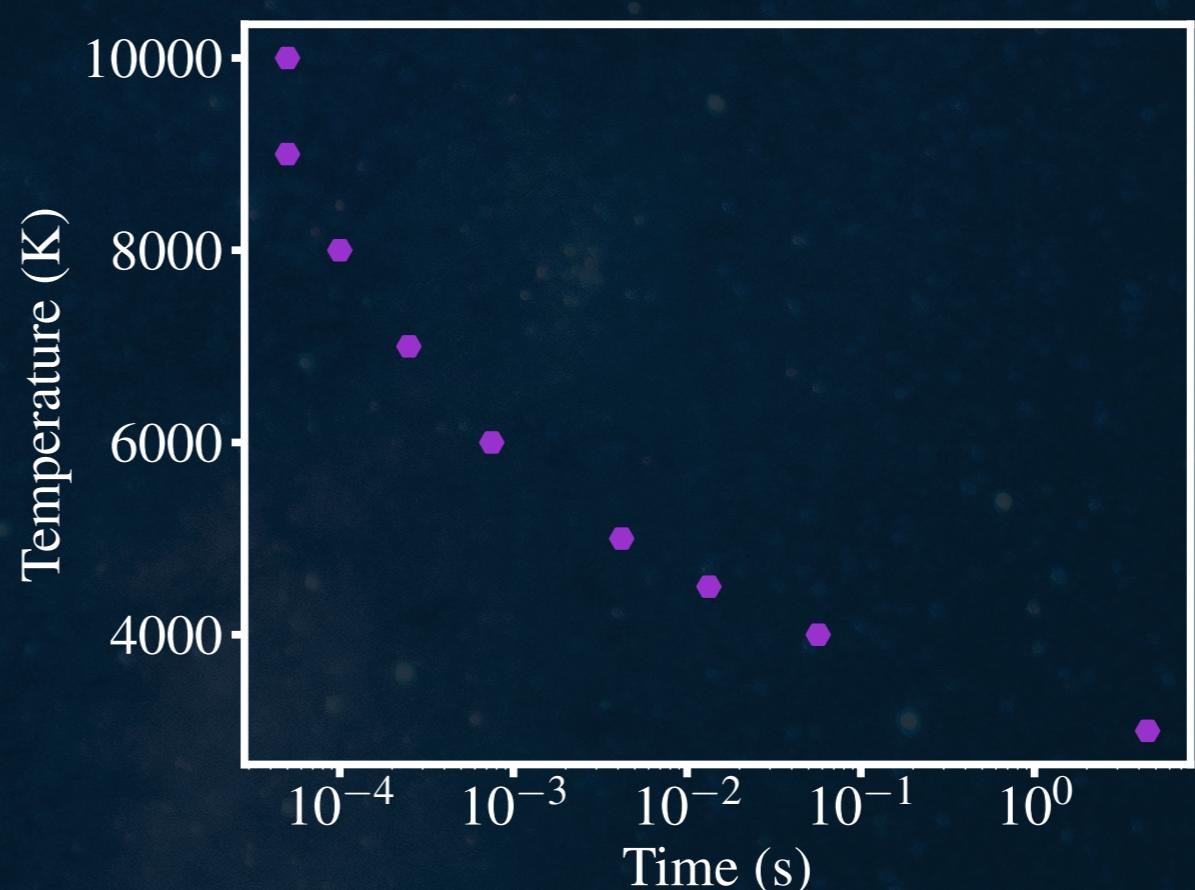
### Impact simulations



- iSALE grid-based hydrocode
- Spherical comet made of pure water ice with a homogeneous HCN distribution
- Solid basalt impact site to simulate surface of early Earth



A simulated impact of a 1km comet hitting the surface of the early Earth with  $v_{imp} = 20 \text{ km s}^{-1}$ . The temperature data traces the material of the comet.



The time taken for 99% of HCN to degrade at different temperatures with our simple chemical model.

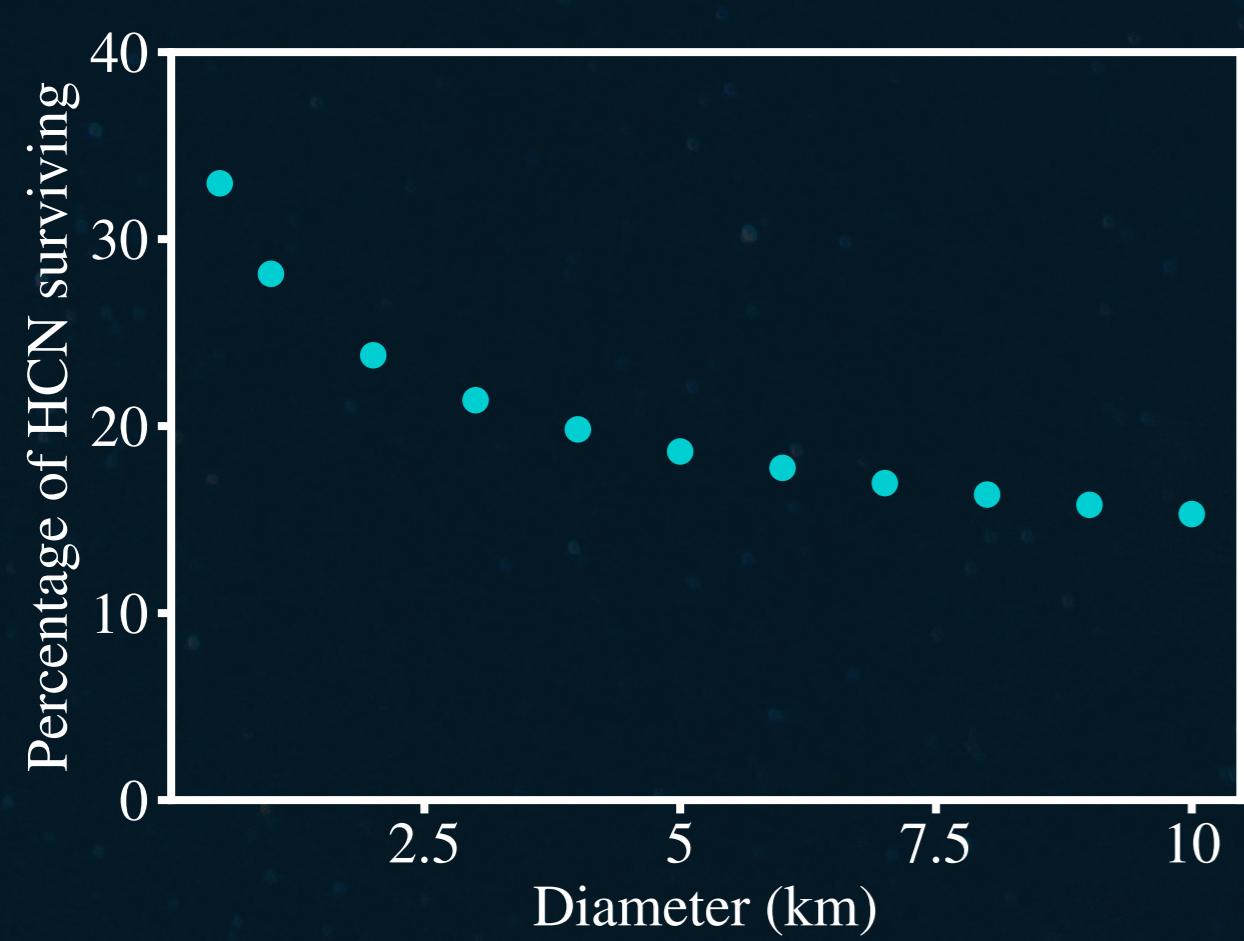
## Chemical Modelling

- Simple model:
  - Thermal decomposition of  $\text{H}_2\text{O}$
  - Radical driven destruction of HCN

## Which cometary impacts are most efficient at delivery? <sup>[3,4]</sup>

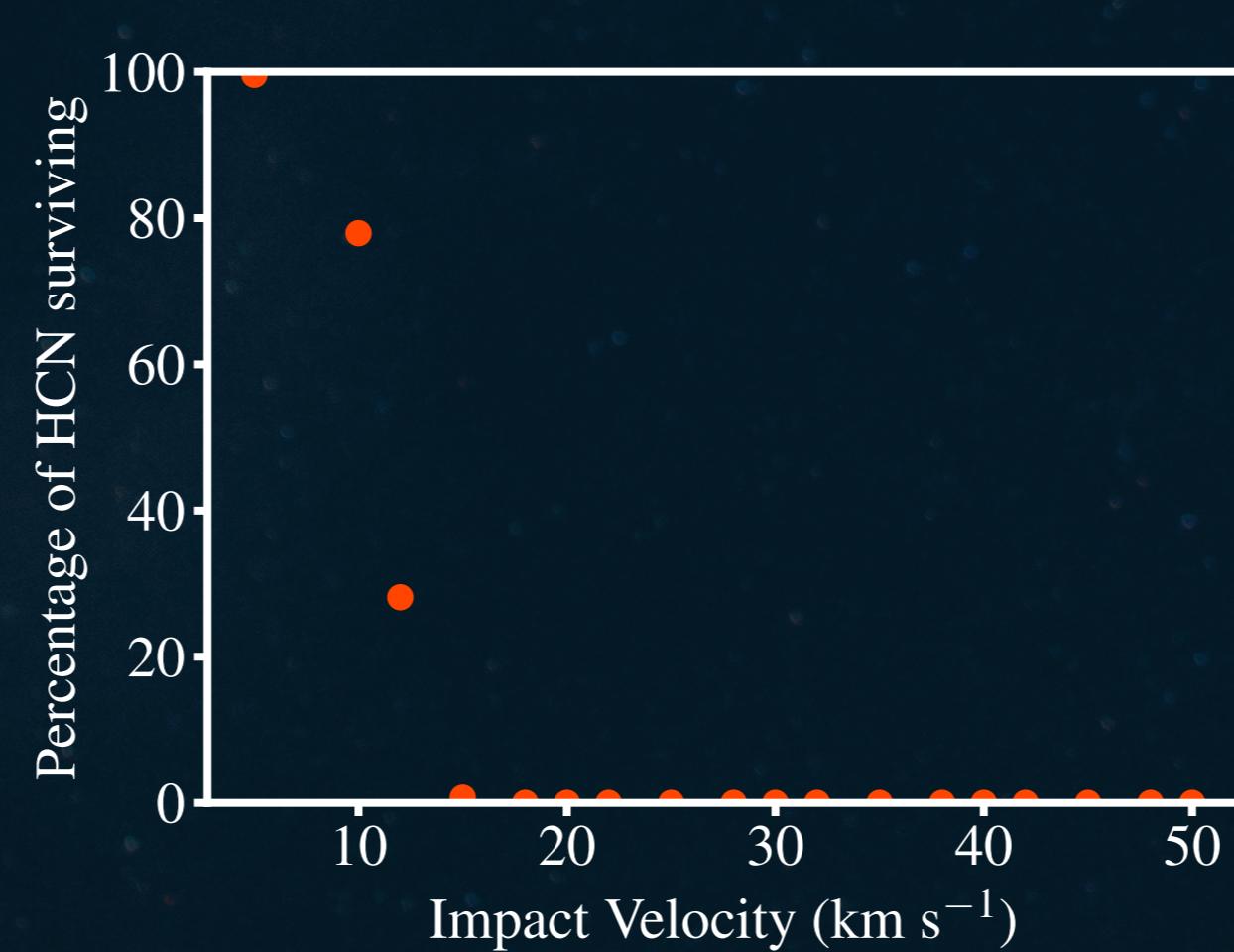
### Small...

The impact shockwave passes through smaller bodies quicker, reducing the time the material stays at high temperatures, boosting HCN survival.



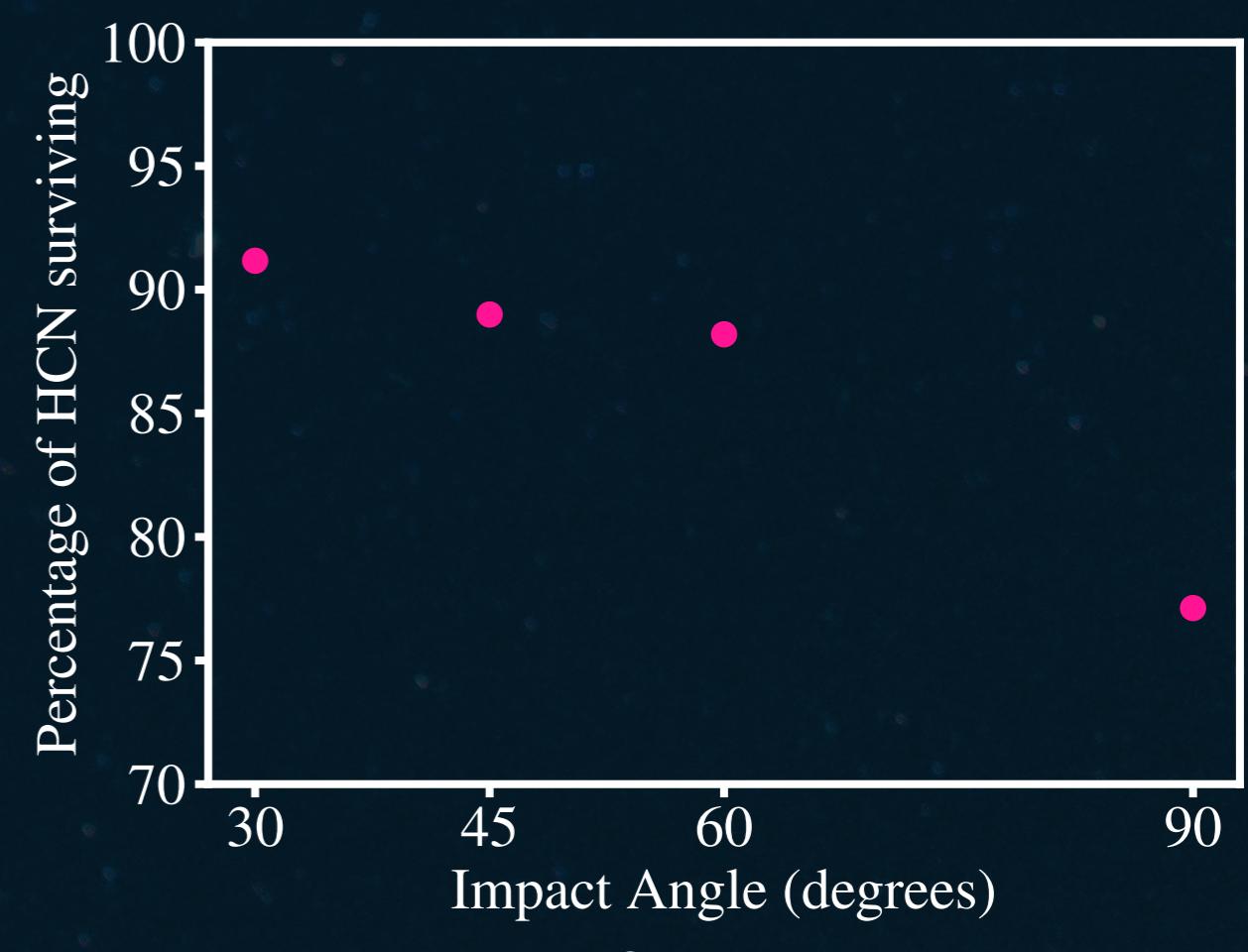
### ...slow...

Higher impact velocities increase the temperatures experienced by the cometary material, efficiently destroying HCN.



### & oblique.

Oblique impacts reduce the temperature experienced by the cometary material increasing HCN survival.



[1] Patel et al., 2015. Nature Chemistry 7, 301–307. doi: 10.1038/nchem.2202

[2] Sasselov, Grotzinger, & Sutherland, 2020. Science Advances 6, eaax3419. doi: 10.1126/sciadv.aax3419

[3] Pierazzo & Chyba, 1999. Meteoritics & Planetary Science 34, 909–918. doi:10.1111/1945-5100.1999.tb01409.x

[4] Todd & Öberg, 2020. Astrobiology 20, 1109–1120. doi: 10.1089/ast.2019.2187

Scan here to see successful and unsuccessful impacts!

