

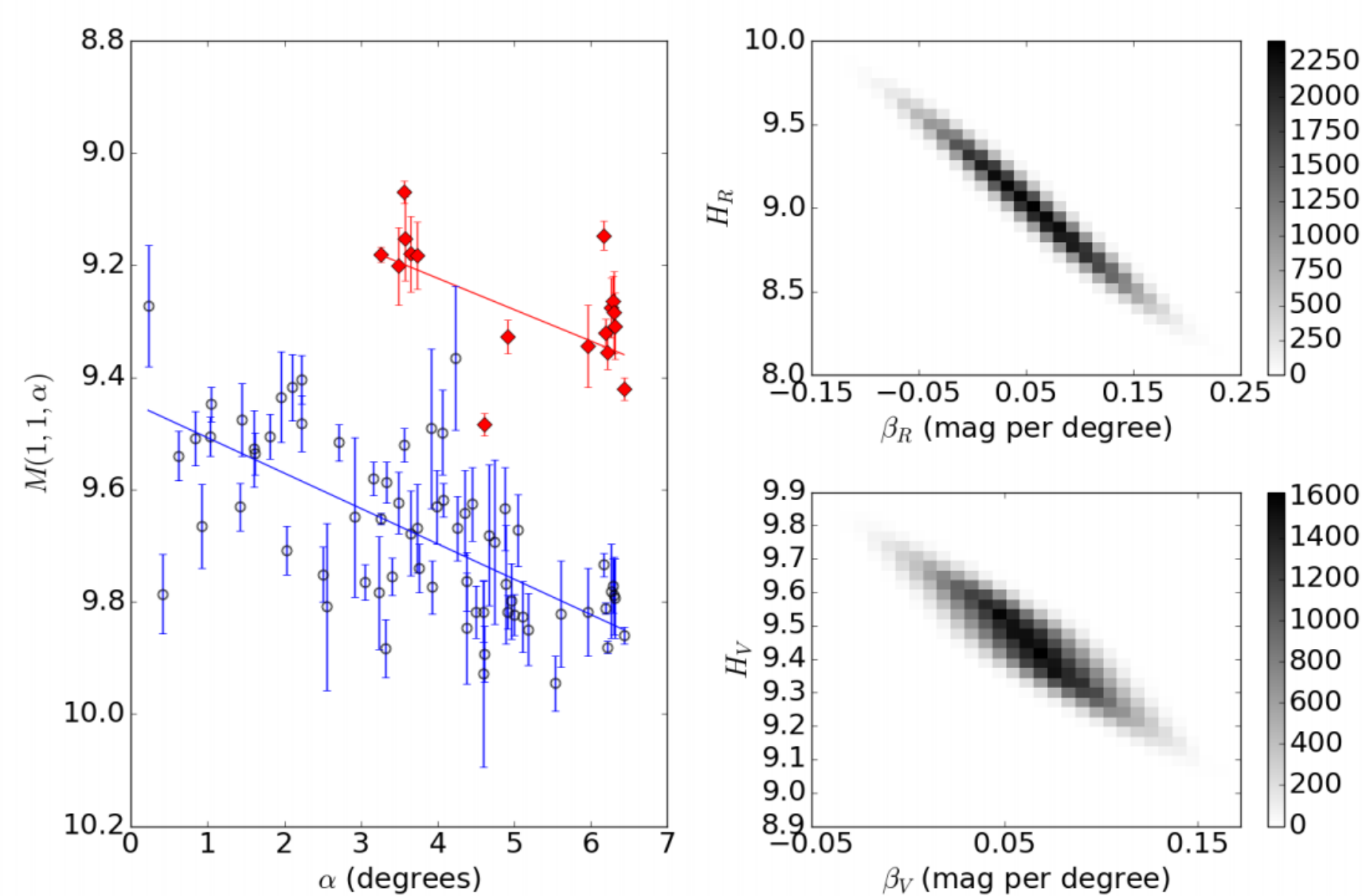
Trans-Neptunian Objects

- **What are they?**
 - Trans-Neptunian Objects (TNOs) are small, distant objects in our Solar System
 - Their relatively small size and massive distance from Earth makes them difficult to observe
 - TNOs are remnants of the protoplanetary disk
 - ~4.6 billion years ago, all the planets in the Solar System formed from a leftover disk of matter known as the protoplanetary disk
- **Why study TNOs?**
 - Understanding the physical characteristics of TNOs is essential to understanding the evolution of the Solar System
 - There are ~2,300 known TNOs, but only a few have been studied extensively.
 - Determining the colors of TNOs sheds light on their composition



Image Credit: NASA – New Horizons

32532 Thereus



This is a phase curve of 32532 Thereus – a centaur that orbits at a Blue points correspond to the violet filter (V), red points correspond to the red filter (R), and the solid lines show the preferred solution as calculated by astronomers. H represents the absolute magnitude.

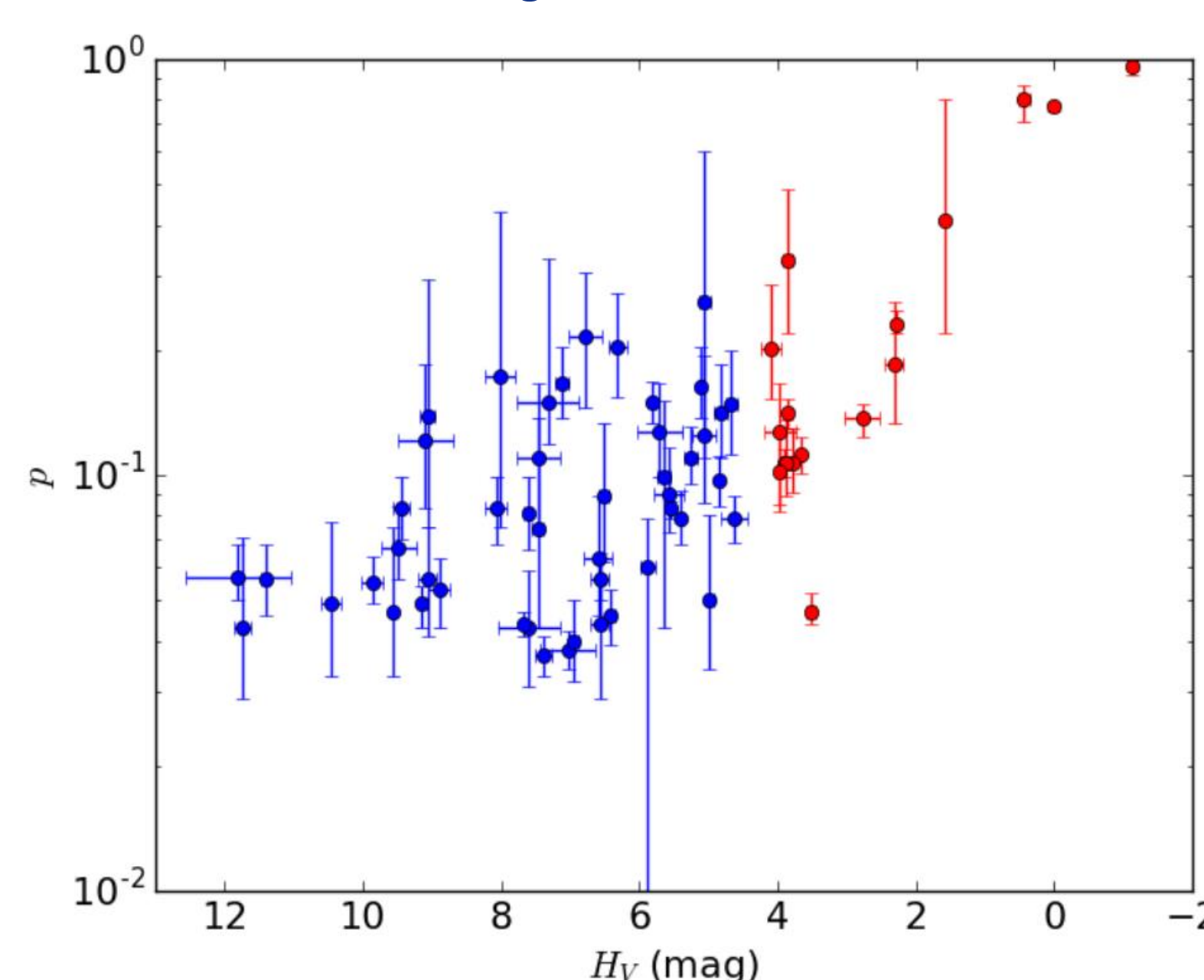
Methodology

- **Photometry**
 - Astronomers use photometry to determine physical characteristics of TNOs
 - This involves measuring the apparent magnitudes and colors of TNOs
 - Apparent magnitude is a measure of how bright an object in space appears from Earth
 - Knowing the apparent magnitude and the distance from Earth allows astronomers to calculate the absolute magnitude of a TNO
 - Astronomers can then view TNOs through special filters to measure absolute color
 - These filters only allow certain wavelengths of light to enter a telescope – this allows astronomers to measure magnitudes in specific wavelengths of light (i.e. color)
- **Phase Coefficients (α)**
 - The phase coefficient is a measure of the angle between the Earth and the Sun as measured from the TNO
 - This is used as a proxy of the distance to the TNO from Earth

Results and Conclusions

- Astronomers found a loose trend showing that TNOs with higher albedos were brighter under the violet filter
- Albedo is a measure of the percentage of light reflected off of a surface as opposed to being absorbed
- Larger TNOs (red) tended to be more blue than smaller TNOs
- Surface temperature did not appear to be a factor when determining color
- Larger TNOs tended to have significantly higher albedos due to resurfacing

Albedo vs Magnitude under Violet Filter



Magnitude under Violet Filter vs Diameter

