New Horizons: Journey to Pluto Power Point Notes

These notes are intended to give you talking points about the science of each image on the slide. Feel free to use your own words, or the ones written, when presenting this to guests in Space Odyssey. Some of the slides have multiple talking points, you are also welcome to choose just one or two from those options.

Ideally this PowerPoint can be presented in 15min.

1. Title Slide

2. New Horizons Spacecraft

New Horizons is a small spacecraft (about the size of a Grand Piano). However, they were able to pack on 7 different instruments, which included imagers and spectrometers. These instruments not only directly measured items of interest, but also provided backup to other instruments on the spacecraft should one fail during the mission. The instruments aboard are:

Ralph: Visible and infrared imager/spectrometer; provides color, composition and thermal maps.

Alice: Ultraviolet imaging spectrometer; analyzes composition and structure of Pluto's atmosphere and looks for atmospheres around Charon and Kuiper Belt Objects (KBOs).

REX: (Radio Science EXperiment) Measures atmospheric composition and temperature; passive radiometer.

LORRI: (Long Range Reconnaissance Imager) telescopic camera; obtains encounter data at long distances, maps Pluto's far side and provides high resolution geologic data.

SWAP: (Solar Wind Around Pluto) Solar wind and plasma spectrometer; measures atmospheric "escape rate" and observes Pluto's interaction with solar wind.

PEPSSI: (Pluto Energetic Particle Spectrometer Science Investigation) Energetic particle spectrometer; measures the composition and density of plasma (ions) escaping from Pluto's atmosphere.

SDC: (Student Dust Counter) Built and operated by students; measures the space dust peppering New Horizons during its voyage across the solar system.

3. New Horizons Trajectory

Here's a scale diagram of our solar system. To give you an idea of scale, the distance between Earth and the Sun is 93 million miles.

New Horizons traveled 3 billion miles to reach Pluto – this is the furthest distance a spacecraft has ever traveled to complete its primary mission!
To be able to complete such a long journey in a relatively short period of time, New Horizons was built to be as lightweight as possible and put on a very large rocket. This combination has been called “ferocious” by mission scientists and resulted in New Horizons being the fastest spacecraft ever launched. It left Earth at an impressive 36,000 miles per hour. It reached the orbit of the moon just nine hours after it was launched, which is ten times faster than the Apollo missions! (It took the Apollo astronauts 3 days to get to the moon)

New Horizons is continuing on past Pluto and is now over 200 million miles from Pluto.

4. New Horizons Flyby Path
When New Horizons arrived at Pluto, it was traveling at 32,500 miles per hour. This incredible speed allowed the spacecraft to get to Pluto relatively quickly, but it also meant that all the spacecraft could do was a flyby. It would have taken more fuel than New Horizons ever had on board to be able to slow down the spacecraft and allow it to be captured by Pluto’s relatively weak gravity to go into orbit.

Above is a view of the path New Horizons followed through the Pluto system. Scientists utilized every minute they could to collect data on Pluto, Charon, and Pluto’s four smaller moons. The goal of the fly-by was the map the surface of Pluto and Charon, study the atmosphere and geology of Pluto and Charon, and to image Pluto’s smaller moons.

5. Hubble Image of Pluto
So why did we send a spacecraft to Pluto? Well, Pluto is only 1400 miles across, so even with our best telescope (Hubble Space Telescope) this was the best picture we had, still exciting astronomers though with evidence of a varied surface. Scientists had to do a lot of processing of the imaging to get even this level of detail. However, this was much more detail than scientists had ever know about the surface of Pluto. We could see that the surface had distinct light and dark areas. This, in combination with spectroscopy and other observations of Pluto helped to start to reveal the mysteries of this small, icy world.

6. Pluto Compared to Australia
Here is what 1400 miles across looks like. Pluto is smaller than Australia!

7. Pluto Moon Systems – Hubble Image
The more we observed Pluto, it became more clear that the Pluto system was more complex than previously thought. Approximately 40 years after Pluto’s discovery, Pluto’s largest moon, Charon, was discovered. It is almost half the size of Pluto. Because they are so close in size and mass, they actually orbit each other, which causes Pluto to wobble.

Nix and Hydra were discovered in 2005 by members of the New Horizon Team using the Hubble Space Telescope to study Pluto. Those were the last moons found before New Horizons launched.

Then, in 2001, Kerberos was discovered between the orbits of Nix and Hydra. Styx was discovered in 2012 by a team of scientists searching for potential hazards to the New Horizons spacecraft flyby in 2015.
The image here was taken by New Horizons exactly 85 years after Pluto’s discovery – in early 2015.

8. **New Horizons First Color Image of Pluto**  
As New Horizons approached Pluto, the images continued to improve. This is the first color image of Pluto and Charon released by the New Horizons team. Although not the high resolution images that we would get from the flyby, this image was already a great improvement on the earth-based images. Here, we could see that Pluto and Charon are distinctly different colors and thus made of different materials. It was originally thought that Charon coalesced from debris jettisoned into space after an object smashed into Pluto. However, this discovery could change formation theories of the Pluto system. This image was taken by the imager Ralph.

9. **June 30th – Pluto and Charon from New Horizons**  
On June 30th, just a couple of weeks before the flyby, we could start seeing even more detail. At this distance, surface details were already becoming clearer. For instance, we can see hints of what would be called the “dark pole” or “Mordor” on Charon.

10. **Pluto and Charon, Pluto’s non flyby side**  
This image was taken just a few days before the historic flyby. It shows the highest resolution image we will ever have of the side of Pluto facing away from the spacecraft during the fly-by. We started to see interesting features on Pluto, like some of the hexagonal features seen to the right of Pluto. We also see the “dark pole” on Charon in greater detail.

11. **Heart of Pluto Image**  
This is probably the most famous image of Pluto now. This image was sent back from the spacecraft just two days before the fly-by. Dominating the image is the “heart of Pluto.” In this image, we see a complex surface. Some areas are cratered and thus relatively old, other areas, like the heart, are not. This indicates that Pluto has a long, complex geological history.

There are multiple colors on the surface indicative of different materials on the surface. Then, there is that distinct orange/red color. We know that the surface is a mix of water, nitrogen, and methane ices. Scientists believe Methane particles could somehow be lofted off of the surface and irradiated by cosmic rays and UV light. This causes hydrocarbon molecules to form and cause the reddish-brown/orange color.

12. **Tomabaugh Regio Mountains**  
Here is one of the first images released from the fly-by. This was taken from within the heart region of Pluto. Here, we see mountains of water ice that is so cold that it is hard as rock. These mountains rise as high as 11,000 feet high! What was so shocking about this image is the lack of impact craters. Like the rest of Pluto, this region would have presumably been bombarded by space debris which would have left craters. The lack of craters indicates that this is a young surface and that these mountains likely formed only 100 million years ago. They may still be in
the process of building. This is one of the youngest surfaces that we have ever seen in the solar system, which was very surprising.

13. **Edge of Tombaugh Regio and Cthulhu Regio**
   In this image we see a second mountain range in Pluto’s heart region (more officially known as Tombaugh Regio). In this image, we can see features as small as a half-mile across! These mountains are estimated to be about one-half to one mile high, approximately the same altitude as the Appalachian Mountains on Earth.

   This image also shows the well-defined topography along the western edge of Tombaugh Regio. There is a distinct difference in texture between the younger, frozen plains of Tombaugh Regio and the heavily-cratered terrain to the west. These darker surfaces are probably billions of years old.

14. **Sputnik Planum – Snakeskin Texture**
   In the northern region of Tombaugh Regio, an area called Sputnik Planum, we see Nitrogen ice flows. Scientists believe that this ice flow is similar to glacial flows on Earth. At the cold temperatures of this region (-390 degrees Fahrenheit), water ice freezes as hard as rock. Both other ices, like Nitrogen, Carbon Monoxide, and Methane would still be soft enough to behave like water-ice glaciers do on Earth. These ice flows, and the lack of craters mean that this surface is very young geologically. These flows may still even be active today.

   Again, this was a huge surprise to scientists. They are still not sure what is driving Pluto’s geological activity. However, the leading theory is that remnant heat deep inside Pluto could be generating slow, bubbling convection to produce the ice blocks and flows observed in Sputnik Planum.

   In this image we also see a snakeskin like texture that looks reminiscent of dunes on earth. Scientists don’t have any theories as to what may be causing this structure.

15. **Mountains and Atmosphere**
   Along with showing more of the beautiful surface of Pluto, this image was one of the first images where we could directly observe Pluto’s atmosphere. Here, you can see all of the different haze layers in the atmosphere. Scientists believe this layered “smog” is being caused by the interaction of the methane in the atmosphere with sunlight.

16. **Pluto’s Atmosphere**
   Before New Horizons, scientists knew that Pluto had an atmosphere of Nitrogen. They could tell this by looking at the light from stars as Pluto passes in front of them. They found that the starlight dimmed before being blocked out by Pluto crossing the star. From spectroscopy, they were able to deduce that Pluto had an atmosphere of Nitrogen. But the extent of the atmosphere and what was causing it was still unknown.
New Horizons was able to directly image the atmosphere of Pluto. We see that it is more complicated than previously thought. Before this image, scientists had hypothesized that as Pluto went past perihelion, the closest point in its orbit to the sun, that the nitrogen-rich atmosphere would freeze and disappear. However, this hasn’t been the case. It has, in fact, been thickening since then.

Scientists working with New Horizons have observed that Pluto’s atmosphere extends as far as 1,000 miles above the surface of the planet. That is five times higher than previously expected! However, even with this extended atmosphere, the surface pressure on the surface of Pluto would be 10,000 times lower than Earth’s at the surface. This was much lower than scientists were expecting but indicative that Pluto is going through global change.

17. Charon and “Mountain in the Moat”
Along with these stunning new results from Pluto, New Horizons has also imaged three of Pluto’s moons.

Here you can see a close-up view of Charon from the fly-by. Here, we see the dark region near the pole of Charon (informally being called “Mordor”). Early thoughts are that this could be the result of material migrating over from Pluto. At about 2 o’clock you can see a notch. That is a canyon that is about 4 to 6 miles deep. Around the planet’s middle you can see a huge sash of canyons. This is about 600 miles across and could be the result of active geology on Charon. Scientists are still not sure what could be causing the unexpected active geology on Charon.

In an even closer view, you can see what is being called the “Mountain in a Moat.” (upper left of yellow framed image). The image shows an area approximately 240 miles across. So far, no one is sure what has caused this feature.

18. Pluto’s Smaller Moons as seen by New Horizons
New Horizons also provided us with our first view of three of Pluto’s moons – Nix, Hydra, and Styx. In these images, we can see features on Nix that are as small as 2 miles across and 0.7 miles on Hydra.

Hints of a bulls-eye pattern in the discolored area on Nix have scientists speculating that the red area could be inside an impact crater.

19. Images of Pluto through the Years (animated gif)
A compilation of the view of Pluto throughout the years.

New Horizons is now on a course to flyby another Kuiper belt object in 2019, and there are hopes NASA will approve this extended mission soon.