

## Voyager 2

Toward the end of the twentieth century, the four giant planets moved into a configuration that I called the Grand Curve, because it made possible a Grand Tour. Ahead of Jupiter was Saturn, ahead of that Uranus, ahead of that Neptune. Thus a spacecraft by passing close to each could get a gravitational “slingshot” acceleration that would redirect it into a new leg of orbit to the next.

The four spacecraft that took advantage of this were launched from Cape Canaveral in Florida. Pioneer 10, launched in 1972, flew by Jupiter in 1973, and departed on a trajectory out of the solar system. (It was the first to do either of these things.) Pioneer 11, launched 1973, flew by Jupiter in 1974 and Saturn in 1979. Voyager 1, launched 1977, flew by Jupiter in 1979 and Saturn in 1980. Voyager 2, launched 1977 (a few days before Voyager 1), flew by Jupiter in 1979, Saturn in 1981, Uranus in 1986, and Neptune in 1989.

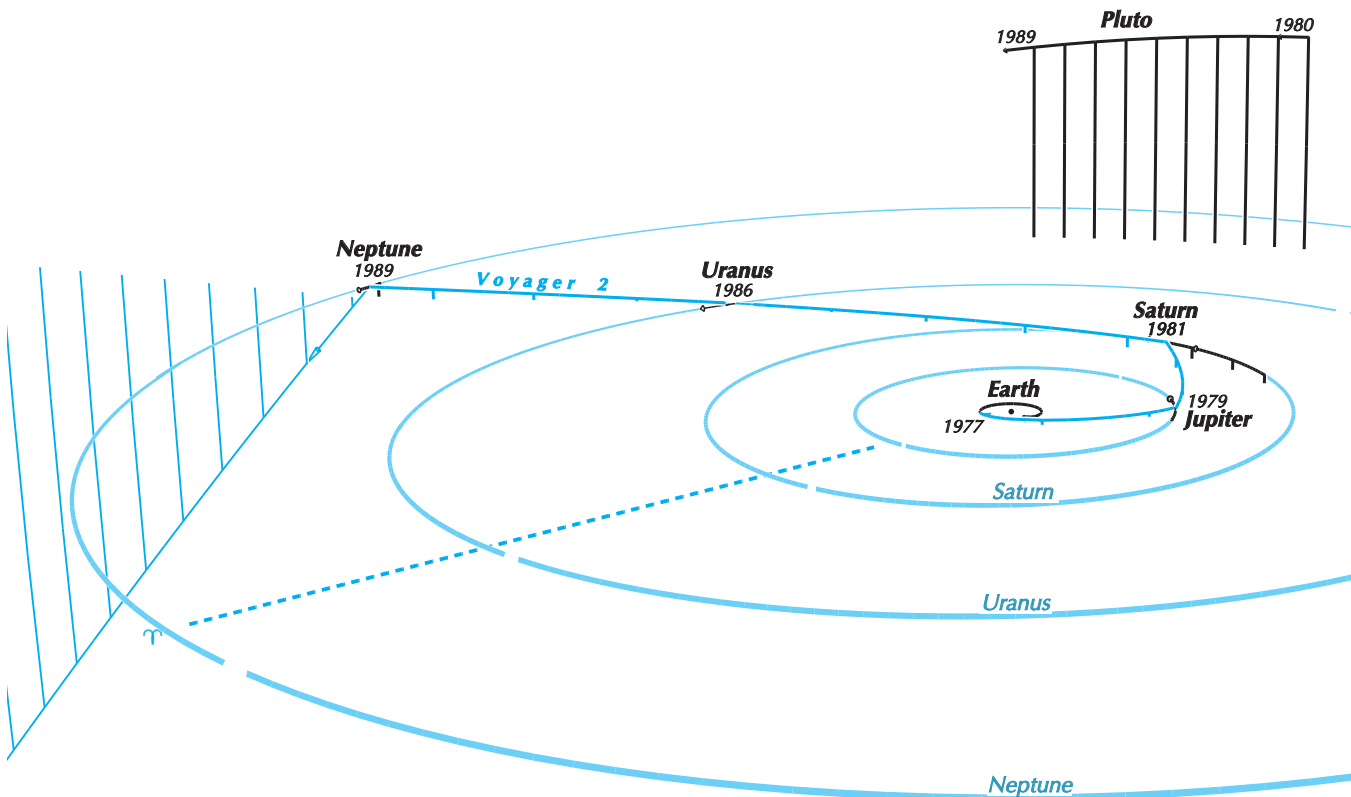
These spacecraft gave us the first close-up views of the four giant planets and their satellite and ring systems. Voyager 2 is still the only one to have visited Uranus and Neptune.

## New Horizons

Pluto could not be included in that Grand Tour: it was much too far back in its orbit to fit into the Grand Curve. It had to wait for a later mission, designed specially for it.

This was the New Horizons probe, long planned, and launched 2006 Jan. 19 from Cape Canaveral. On the way out, it happened to fly by an asteroid (discovered in 2002), which got the name 132524 APL because the spacecraft had been built at APL, the Applied Physics Laboratory of Johns Hopkins University. New Horizons looped by Jupiter on 2007 Feb. 28 to get a boost of speed, and on 2015 July 14 it flew by Pluto at a distance of 12,500 km and Charon at 28,800.

Not long after passing Pluto, in October and November of 2015, New Horizons had its course corrected four times so that it on 2019 Jan. 1 it will fly by another transneptunian, called 486958 2014 MU69. This, at 43.4 astronomical units, will become the most distant body yet visited by a spacecraft.



The Grand Curve. The four giant planets came into the lucky configuration in which each is behind the next one outward; this happens rarely, and soon ceases as the speedier inner planets overtake the outer ones. Thus each planet can “sling” a spacecraft toward the next.

I would have liked to include the 2006-2015 trajectory of New Horizons to Pluto, but have not been able to persuade the authorities to give me usable orbital elements for it.

Stalks connect the planets and spacecraft to the ecliptic plane at intervals of one year. The dashed line is the vernal equinox direction.