

IR Spectroscopic Monitoring of Supernova 2002hh

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Supernova 2002hh was discovered in the galaxy NGC 6946 in Oct. 2002. It is a type II supernova, which means that it resulted from the collapse of the core of a massive star at the end of its lifetime. The objective of the observations is to understand the nature of the explosion mechanism and the preceding evolution of the progenitor star.

At a distance of 6 Mpc, SN 2002hh is one of the nearest supernovae of modern times, thus giving us an exceptional opportunity to study in detail the nature and origin of these gigantic explosions. The supernova is lying behind a thick screen of dust which effectively blocks out much of the optical region. (At 550nm the dust attenuates the supernova flux by a factor of about 1000.). Fortunately, attenuation at IR wavelengths is much less, making this an ideal target to study with the state-of-the art IR spectrograph, SpeX.

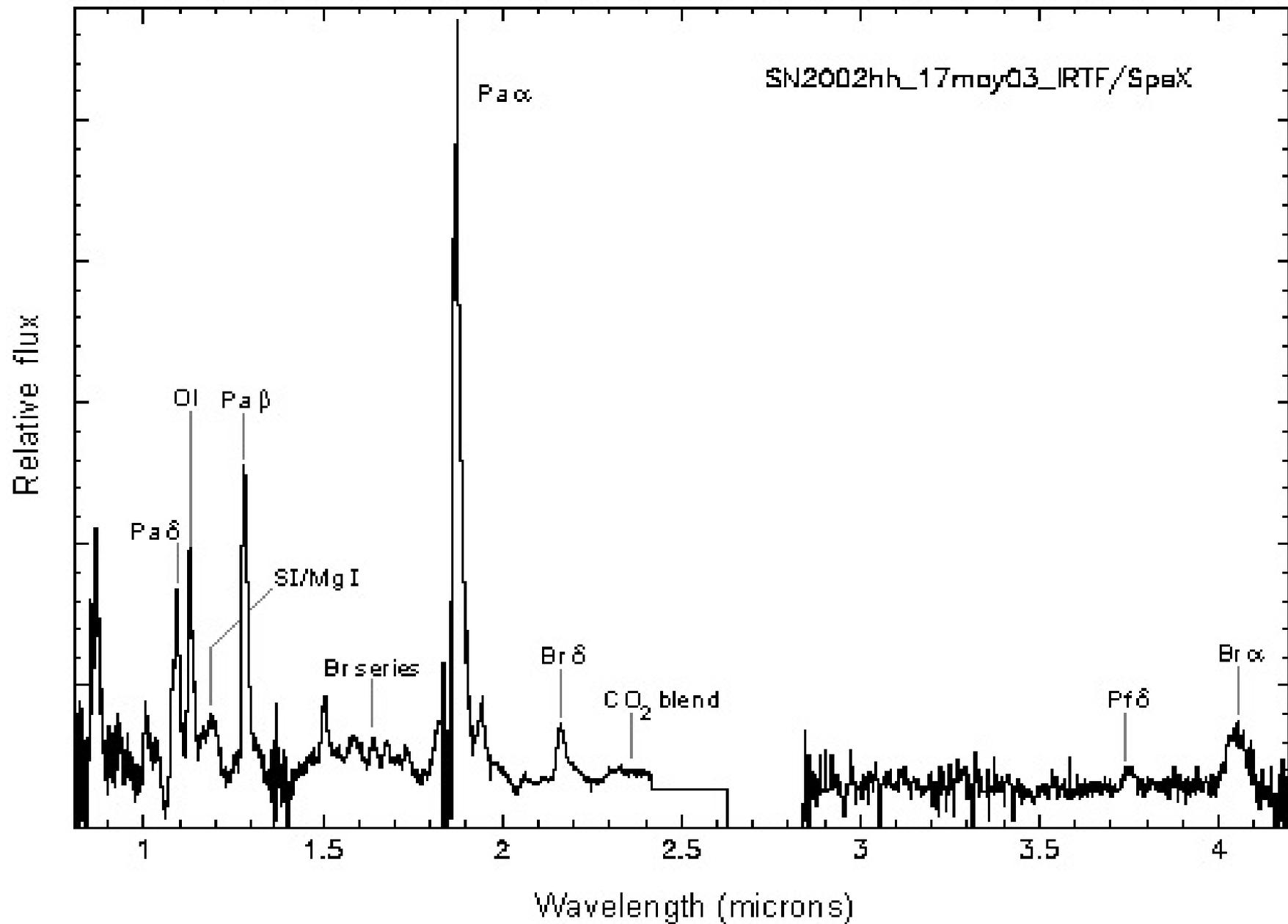
In March this year, a series of IR spectroscopic observations of SN2002hh were conducted using SpeX at the IRTF. These observations are vital for measuring the total mass and distribution of elements in the explosion.

To obtain a really clear view of the ejecta, it is necessary to wait until the supernova has expanded sufficiently - this usually means waiting until it is at least 6 months old. Unfortunately, most supernovae are too far away so that by this time they are too faint to observe in detail. That is why the close proximity of SN 2002hh makes it such an important supernova event.

In the Figure, we show a SpeX IR spectrum of SN 2002hh taken when the supernova was about 200 days old. This is the most complete near-IR spectrum of a supernova ever obtained at this crucial late phase.

The spectrum is dominated by strong broad lines of elements in the expanding ejecta. The lines are driven by the decay of radioactive cobalt produced by the explosion. The most dramatic of these is the hydrogen Paschen alpha line at about 1.9 microns. This line is seldom seen as it lies in a particularly opaque part of the earth's atmospheric window. However the availability of SpeX at the high altitude of Mauna Kea has allowed the best ever observation of this line in any supernova.

0.8 – 4.2 μ Spectrum of SN2002hh



Lines of helium, nitrogen, oxygen and magnesium are also seen. Moreover, carbon dioxide has also been clearly detected. This is a powerful coolant and may lead to the formation of dust grains in the ejecta. Supernovae are suspected to be a major source of dust in the universe and the presence of new dust in SN 2002hh is expected to be observed at a later stage.

This is only the second time for which a spectrum has been obtained of a supernova in 2.9-4.1 micron range (the other was SN 1987A which was 100 times closer!). The big interest in this region is the strength of the continuum. The cause of this emission (also seen in SN 1987A) is still a mystery. It may result from many high excitation lines produced by iron-group elements deep in the core of the explosion. Future observations should help us to resolve this puzzle.