THE RECENT MEGA-OUTBURST OF COMET 17P/HOLMES AT MILLIMETER WAVELENGTHS.
M. Drahus[1], L. Paganini[1], L. M. Ziurys[2], W. Peters[2], C. Jarchow[1], and P. Hartogh[1], [1]Max-Planck-Institut für Sonnensystemforschung, Max-Planck-Str. 2, 37191 Katlenburg-Lindau, Germany, drahus@mps.mpg.de, [2]Arizona Radio Observatory, 933 North Cherry Ave., Tucson, AZ 85721.

Introduction: On Oct. 23/24, 2007, the Jupiter family comet 17P/Holmes underwent an event which eventually raised its optical brightness by a factor of a million, making it an easy object to see with the naked eye. It was the greatest cometary outburst ever observed. The explosion occurred nearly half a year after the perihelion passage, at the helio- and geocentric distances of 2.4 and 1.7 AU respectively. At the same time the comet was perfectly placed in the Northern hemisphere, prompting several observing campaigns.

High-resolution spectroscopy at millimeter wavelengths is a powerful tool for studying the gas environment in comets, thus it is ideal for characterizing the cometary explosions. Through the rotational transitions it allows investigation of the molecular composition and the physical conditions (such as a kinetic temperature, an expansion velocity, and a spatial density) within the coma observed.

Observations: We traced this astonishing event within the Arizona Radio Observatory in USA. The campaign was divided into two main parts:

Part I. Everyday between Oct. 25.5 and 31.5, 2007 (UT), we were using the 12-m telescope on Kitt Peak. The highest spectral resolution was 24.4 kHz.

Part II. On Nov. 28, Dec. 5, Dec. 28, 2007, and Mar. 13–16, 2008, we monitored the HCN J(3–2) transition using the Submillimeter Telescope on Mt. Graham. Because the target line was at best very faint, the highest useful resolution was equal to 1 MHz.

Results and discussion: During part I of the campaign the following molecules were detected: HCN, CS, CH_3OH, H_2CO, and H_2S. We also obtained a sensitive upper limit on CO. The follow-up observations of HCN, conducted as the part II, resulted in the last detection on Dec. 5, 2007, and the last sensitive upper limit on Mar. 13–16, 2008.

The early evolution of the outburst was traced through the J(1–0) transition of HCN and the J(3–2) transition of CS. We observed that the lines were continually fading until Oct. 28, 2007, and then the intensities temporarily stabilized, and the spectral profiles underwent a dramatic change as presented in Fig. 1.

Furthermore, the early spectra are very informative concerning the physical conditions in the gas environment shortly after the outburst. Using the spectrum of CH_3OH (Fig. 2) we determined a rotational temperature of 50 ± 5 K, whereas the HCN and CS line profiles suggest a gas-expansion velocity of about 1 km/s.

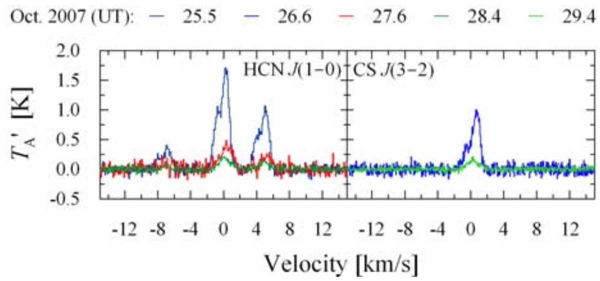

Figure 1: The early evolution of the outburst.

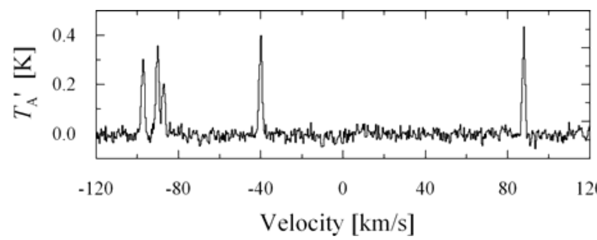

Figure 2: CH_3OH at 157.225 GHz. The spectrum was re-binned to the resolution of 195.2 kHz in order to increase the S/N ratio.

The late monitoring shows that the comet was loosing its excessive activity very quickly. Only two months after the explosion, the detected HCN J(3–2) line was not much brighter from what should be expected for a typical nucleus of that size at that heliocentric distance. If we also assume that at least a part of this late activity was originating from the icy grains blown at the outburst, the scenario that the nucleus was behaving like nothing had happened two months before seems very realistic.

Conclusions and future work: By running our monitoring very quickly, within less than two days from the onset of the outburst, we could characterize the molecular environment in the very early stages of this event. With the further follow-up observations we witnessed the amazing speed at which the comet was returning to its regular activity.

The next step is to retrieve the wealth of information from the spectral line profiles and intensities. Although it is a very challenging task, it can provide a detailed portrait of the outburst and its evolution – the unique clues to understand the processes occurring inside the nucleus which triggered this spectacular event.