SWIFT Observations of the Long Term Activity of Comet C/2009 P1 (Garradd). D. Bodewits*[1], T.L. Farnham[1], M.F. A'Hearn[1], and W. B. Landsman[2]. *dennis@astro.umd.edu, [1]Department of Astronomy, U. Maryland, College Park, MD 20742, USA, [2]AdNet/ASA Goddard Space Flight Center, Greenbelt, MD 20771, USA,

The differences between the two comets investigated by the Deep Impact probe, 9P/Tempel 1 and 103P/Hartley 2, illustrate the complexity of cometary activity. Both comets produced comparable amounts of gas and dust during perihelion, but it was discovered that water and CO_2 are active at entirely different levels in these two comets. Tempel 1 was characterized by irregular bursts of activity [1] from what appeared to be a heterogeneous nucleus [2]. In the hyperactive comet 103P/Hartley 2, it was found that CO_2 is the primary driver of activity, expelling large quantities of sublimating ice grains [3]. Both comets were targeted close to their peri-helions and it is unknown how the water and CO_2 driven activity varies along their orbits.

Here, we report on Swift's UV-Optical Camera (UVOT) observations of comet C/2009 P1 (Garradd). C/2009 P1 is a dynamically new comet and this is likely its first journey to the inner solar system since its emplacement in the Oort cloud. It was discovered in 2009 and had a clear dust coma as far as 8.5 AU from the Sun. We observed the comet on part of its inbound trajectory in and found that at a distance of 3.5 AU from the Sun it produced several tons of gas and dust per second (Fig. 1). Between 3.5 and 2.5 AU the comet's dust production rate steadily increased with the heliocentric distance as r_h^{-2}, but at the same time we noted a steep increase in the comet's OH production rate, suggesting the onset of a new source of OH. In fact, Garradd is a very dusty comet, compared to the low-dust comet 103P/Hartley 2 (Fig 2.), and its behavior is very similar to the behavior of comet Hale-Bopp at comparable heliocentric distances [4].

Swift/UVOT observed comet C/2009 P1 (Garradd) at regular intervals at heliocentric distances between 3.5 and 1.7 AU on its inbound trajectory, and will continue to do so now the comet is moving away from the Sun. We used the UV grism on Swift-UVOT to quantitatively measure gas and dust content in the coma [5]. Broadband uvw1 and v-filter observations provide context to our grism observations and allow for independent measures of the OH and dust content in the coma. The sensitivity of Swift's grisms permits the observation of a comet far away from the Earth and the Sun when it is outside the grasp of most ground based observatories.

References: [1] M. F. A'Hearn et al., Science 310, 258 (2005). [2] L. M. Feaga, et al, ICARUS 191, 134 (2007). [3] M. F. A'Hearn, Science, 1–22 (2011). [5] N. Biver et al., Science 275, 1915–1918 (1997). [5] D. Bodewits et al., AJ 141, p12 (2011).

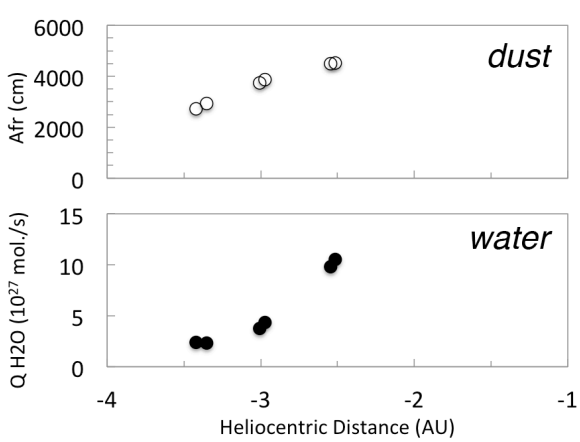

Figure 1 *–Swift observations of the gas and dust production rates of comet Garradd on its inbound trajectory suggest the onset of new source of water around 3 AU.*

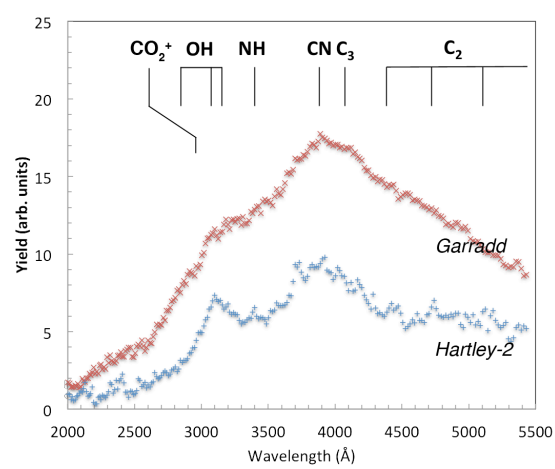

Figure 2 *– Processed UVOT grism spectra of the very dust-rich comet 2009 P1 Garradd at 2.0 AU (red) and the very gas-rich Hartley-2 (blue).*