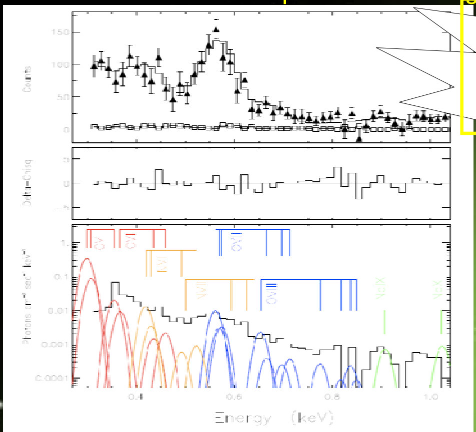
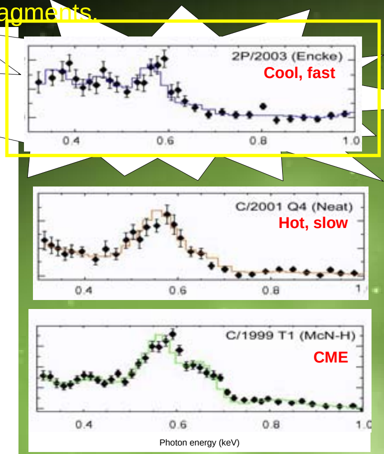
Chandra's Close Encounter with the Disintegrating Comet SW3/73P- Fragment B

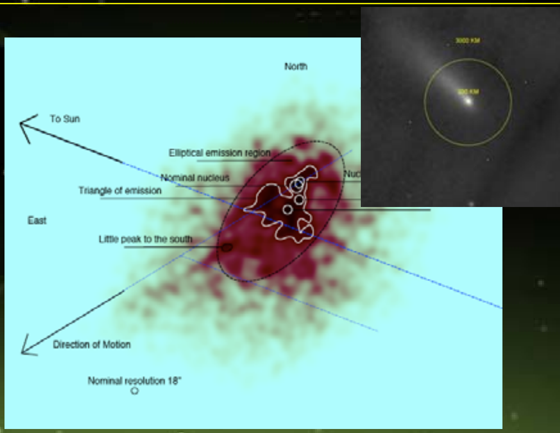
S. J. Wolk (CfA), C.M. Lisse (APL), D. Bodewits (KVI),
D. J. Christian (UQB) & K. Dennerl (MPE)

On May 23, 2006 we used the ACIS-S instrument on Chandra to study the X-ray emission from the fragment B of comet 73P/Schwassmann-Wachmann 3 (SW3B). By 2006, this comet had split into at least 43 tracked elements and countless additional pieces. It also passed closer to the Earth in May 2006 than any comet yet detected in the X-ray.

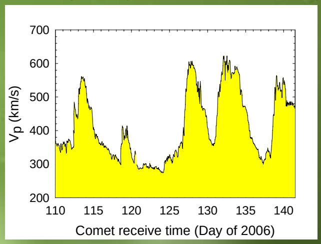
We obtained a total of 20 ks of observation time of fragment B, and have contemporaneous ACE and SOHO solar wind physical data. The Chandra data allow us to spatially resolve the detailed structure of the interaction zone between the solar wind and the coma at a resolution of ~75 km, The extended peak in the X-ray data may indicate emission from separate comet fragments.





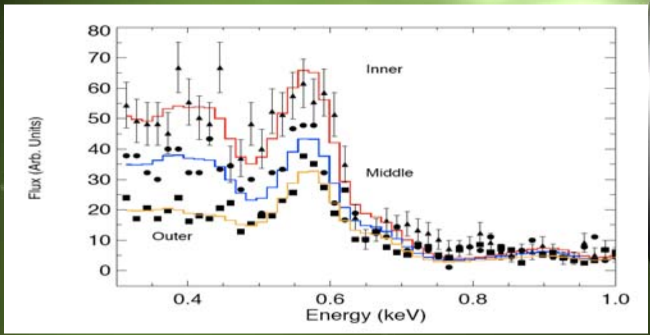


False color image of SW3B in the 0.3-1.2 keV band. Red, green and blue colors are the X-ray data at various smoothings and scalings. Inset: R-band image taken the same day (Courtesy of Faulkes Obs). Images are at the same spatial scale.



Proton velocity, measured by SOHO/celias and mapped to the comet's position. The observation took place on day 143, with a quiescent Solar wind.

SW3 B's X-ray spectra is very similar to that of 2P/2003 (Encke) (Lisse et al. 2005) and demonstrates the typical features of comet-solar wind charge exchange emission from highly charged C, N, O and Ne. The data were fit to obtain solar wind ionic abundances. Since ACE is in front of Earth and comet, it gives us a direct measure of the relevant part of the solar wind. The spectrum of the comet is well fit by a charge exchange model containing two species each of four ions (C,N,O and Ne) and a solar wind speed of about 450 km/s.



Comparison of spectra within the comet. Spectra are all fitted with a wind velocity of 450 km/s. All regions show strong OVII. The outer regions show relatively weak CVI and CV.

The close proximity of SW3B provided unprecedented spatial resolution. This allowed us to investigate the spatial behavior of the charge exchange emission. We find that the line intensities change as the spectra move inward. Oxygen become stronger relative to Carbon. This is due to optical depth effects.

Conclusions:

- Comet SW3B was collisionally thin to charge exchange and interacted with a relatively fast, cool wind associated with a co-rotating interaction region where the fast solar wind is overtaking the slow solar wind.

- In the case of cold fast solar wind much of the energy released by charge exchange is shifted from OVIII to OVI. Moving the luminosity to the EUVE regime.

- The morphology of is roughly elliptical, with a triangular concentration within the ellipse of emission. This morphology can be understood in as the comet flakes apart non-gravitaional forces, especially solar radiation exceed gravity as the prime mover. Particulates move along cartiod trajectories filling the moving from the direction of motion towards the anti-sun direction.

- We can also use this morphological analysis to understand the observation of LS4 in August of 2000. The debris from LS4 was subjected to both solar gravitation and radiation forces. Due to size variations among the debris this caused the the debris to preferentially occupy the region northwest of the nominal position of the nucleus.