

Chandra ACIS-S X-ray Imaging Spectroscopy of EPOXI Target Comet 103P/Hartley 2. C.M. Lisse¹, D.J. Christian², S.J. Wolk³, K. Dennerl⁴, D. Bodewits⁵, J.Y. Li⁵, M.R. Combi⁶, S.T. Lepri⁶, T.H. Zurbuchen⁶, N. Dello-Russo¹, M.M. Knight⁷ ¹JHU-APL, 11100 Johns Hopkins Road, Laurel, MD 20723 carey.lisse@jhuapl.edu ²CSUN ³CXC, Harvard -SAO ⁴Max-Planck-Institut für extraterrestrische Physik ⁵Univ. of Maryland ⁶Univ. of Michigan ⁷Lowell Obs.

Abstract. We present results from the *Chandra* X-ray Observatory's characterization of the x-ray emission from Comet 103P/Hartley 2, in support of NASA's Deep Impact Extended close flyby of the comet on 04 Nov 2010. The comet was observed 4 times for a total on target time of ~60 ksec between the 17th of October and 16th of November 2010, with two of the visits occurring during the EPOXI close approach on 04 Nov and 05 Nov 2010. X-ray emission in 103P was qualitatively similar to that observed for collisionally thin comets 2P/Encke [1] and 9P/Tempel 1 [2]: emission morphology offset sunward but asymmetrical from the nucleus (Fig 1) and emission lines produced by charge exchange (CXE) between highly stripped C, N, O, and Ne solar wind minor ions and coma neutral gas species were found (Fig. 2; [3]). 103P was very underluminous in the x-ray at all times, representing the 3rd faintest comet ever detected [4,5]. The coma was collisionally thin to the solar wind at all times, allowing solar wind ions to flow into the inner coma and interact with the densest collections of neutral gas. Extension of the emission in the direction of the major rotating dust & gas jets was observed, consistent with the major source of cometary neutral gas species being icy coma dust particles. Variable spectral features due to changing solar wind flux densities and charge states were also seen (Fig. 2).

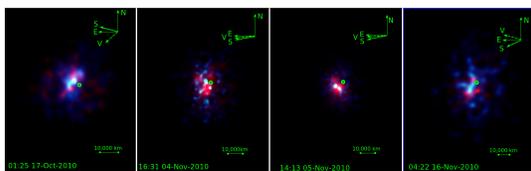


Figure 1 - 3-color narrowband x-ray images of comet 103P/Hartley 2 taken on 17 Oct, 04 Nov, 05 Nov, and 16 Nov 2010 by *Chandra* using the ACIS-S imaging spectrometer. Presented are C & N (red), and O (green & blue) charge exchange emission lines of the comet, smoothed with a 5 pixel x 5 pixel Gaussian filter. The images span a region ~50,000 x 50,000 km around the nucleus. At each visit, the green circle denotes the location of the nucleus and the green arrows North, East, the velocity direction of motion of the comet, and the projected direction to the Sun.

Modeling of the *Chandra* data using observed gas production rates and ACE solar wind ion fluxes with a charge exchange mechanism for the emission is consistent with the temporal and spectral behavior expected for a slow, hot wind

typical of low latitude emission from the solar corona interacting with the comet's neutral coma during the first 3 visits [6]. Changes in the x-ray emission seen in 4th visit on 16 Nov 2010 is similar to the unusual behavior seen for comet 17P/Holmes in 2007 [7] as the solar wind became dominated by a colder, less ionized, and faster plasma more typical of outflow from the solar polar regions [6]. It is likely that the overall faintness of the comet seen during all visits is due to the unusually well mixed dust and gas content of this hyperactive comet's coma.

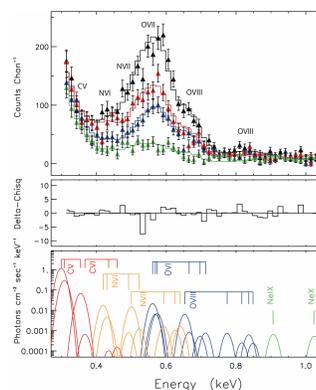


Figure 2 – Comet 103P CXO/ACIS S3 spectra & CXE fit for the Nov 05 (brightest) observation. **Top:** Observed spectra are shown (in order of intensity) for Nov 16 (green, bottom spectrum), Oct 17 (blue), Nov 04 (red), and Nov 05 (black, top spectrum). Over-plotted are ± 1 σ error bars and the best fitting CXE models for each observations. **Middle:** Residuals of the CXE fit to the Nov 05 data. **Bottom:** Individual emission lines for a CXE model indicating the different lines and their strengths for the 05 Nov 2010 observation.

References

- [1] Lisse, C. M., *et al.* (2005) *Astrophys. J.* **635**, 1329
- [2] Lisse, C.M., *et al.* (2007) *Icarus* **190**, 391
- [3] Lisse, C.M. *et al.* (2001) *Science* **292**, 1343
- [4] Dennerl, K., *et al.* (1997) *Science* **277**, 1625
- [5] Wolk, S.J., *et al.* (2009) *Astrophys. J.* **694**, 1293
- [6] Bodewits, D., *et al.* (2007) *Astron. Astroph.* **469**, 1183
- [7] Christian, D.J., *et al.* (2010) *Astrophys. J.* **187**, 447

Acknowledgements. Support for this work was provided by NASA through PATM grant NNX09AB 58G and Chandra GO Award Number 12100872 issued by the Chandra X-ray Observatory Center, the NASA ACE project, via mission grant 44A-1085637, and the NSF via grant AST 0707283.