Cometary solar wind charge exchange process happens when ions in solar wind capture electrons from neutral particles in coma, and decay from excited states to ground states. The study of this process plays an important role in understanding the process itself, the stellar wind represented by the solar wind, the nature and structure of comets and so on. In view of the low frequency and occasional nature of near-Earth comets that bring challenges for observations, the University of Hong Kong is planning to launch a spacecraft in EUV band in the near future, one of whose scientific goals will be observing solar wind charge exchange process in comets. This study is intended to select an appropriate bandpass for the detector. The charge exchange model in the SPEX software package [Liyi Gu et al., 2016] was used to iteratively fit the spectra of five comets observed by ACIS-S3 of Chandra X-ray observatory (CXO ACIS-S3). Taking into account the coronal mass ejection, another three free parameters, abundance of magnesium, silicon and iron, were introduced into the comet 153P/2002 to re-fit. Finally, the fitting results of five cometary spectra in X-ray band were obtained, which helped to predict the spectral lines of comets in EUV band. Next, by comparing with the data in AtomDB we identified some strong EUV emission lines and gave a proposal for the design of the detector by statistics: Select different energy band according to the possible resolution, and at the same time pay attention to the detector’s effective area.

**Abstract**

Cometary solar wind charge exchange is exemplified by solar wind. When approaching the sun (3~4AU), comets can produce coma mainly composed of water molecular and dust particles, and further generate dissociation products such as OH, H and O by photodissociation and photoinization. Electrons in these neutral particles can be captured into excited states by photons in extreme ultraviolet (EUV) and soft X-ray waveband. The study of this process plays an important role in understanding the process itself, the stellar wind represented by the solar wind, the nature and structure of comets and so on. In view of the low frequency and occasional nature of near-Earth comets that bring challenges for observations, the University of Hong Kong is planning to launch a spacecraft detector in EUV band. The coronal mass ejection, another three free parameters, abundance of magnesium, silicon and iron, were introduced into the comet 153P/2002 to re-fit. Finally, the fitting results of five cometary spectra in X-ray band were obtained, which helped to predict the spectral lines of comets in EUV band. Next, by comparing with the data in AtomDB we identified some strong EUV emission lines and gave a proposal for the design of the detector by statistics: Select different energy band according to the possible resolution, and at the same time pay attention to the detector’s effective area.

**Introduction**

What is cometary solar wind charge exchange?

When approaching the sun (3~4AU), comets can produce coma mainly composed of water molecular and dust particles, and further generate dissociation products such as OH, H and O by photodissociation and photoinization. Electrons in these neutral particles can be captured into excited states by photons in extreme ultraviolet (EUV) and soft X-ray waveband. The study of this process plays an important role in understanding the process itself, the stellar wind represented by the solar wind, the nature and structure of comets and so on. In view of the low frequency and occasional nature of near-Earth comets that bring challenges for observations, the University of Hong Kong is planning to launch a spacecraft detector in EUV band. The coronal mass ejection, another three free parameters, abundance of magnesium, silicon and iron, were introduced into the comet 153P/2002 to re-fit. Finally, the fitting results of five cometary spectra in X-ray band were obtained, which helped to predict the spectral lines of comets in EUV band. Next, by comparing with the data in AtomDB we identified some strong EUV emission lines and gave a proposal for the design of the detector by statistics: Select different energy band according to the possible resolution, and at the same time pay attention to the detector’s effective area.

**Data Selection**

Reasons for choosing the five comets:

- Their data can reflect most environments.
- They are in variable cometary environments.
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**Spectra Fitting**

Model: Charge Exchange model from SPEX package

Fitted waveband: 0.4~1.0 keV

- Ignore data below 0.4keV: effective area of CXO ASIS-S3 is small below 0.4keV
- Ignore data above 1.0keV: flux produced by charge exchange is low above 1.0keV

Fitting method: iterative fitting

**Application?**

- To study stellar wind exemplified by solar wind.
- Large coma size (10km) and large cross section: observed easily stable number of comets passing by the earth: diagnose various stages of solar cycles widespread latitudes: almost the only way to study solar wind outside the ecliptic plane. (Bodewits et al., 2012)
- To study cometary structures.

**Research aims?**

- Small quantity (about 30 with X-ray data)
- Low energy resolution
- Lack of high-resolution data especially in solar minimum period and EUV band.

**Research method?**

- Fit cometary data in X-ray band.
- Predict cometary spectra in EUV band.
- Statistically determine strong emission lines in most environments.
- Select the band where the lines are located.

**Fitting results and improvements**

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<td>Normalization coefficient (10^15 cm^-2s^-1)</td>
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<td>22.23</td>
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<td>Ionization temperature (eV)</td>
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<td>Collision velocity (km s^-1)</td>
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<td>abundance of C</td>
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<td>abundance of Mg</td>
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<td>abundance of Fe</td>
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<td>chi-square</td>
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<td>6.38</td>
<td>0.75</td>
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Reduction χ² of 153P/2002 is 6.38. Causes of the error and related correction are discussed below.

**Conclusion**

1. Decision of a focused waveband should depend on possible energy resolution:
   - >200: 80~140 Å
   - 1: a number of strong emission lines
   - all of C, N and O have strong lines
   - <200, >10: 250~370 Å
   - 1: contains emission lines of O^+ and Ne^+, which can be observed in most environments.
   - 2: contains lines emitted by Fe^11+, which can diagnose magnetohydrodynamics activities.
   - <10: 170~250 Å
   - 1: strong emission lines of C^+.

2. Pay attention to instrument response:
   - Because most typical emission lines occur around the edges of suggested wavebands given by the laboratory.
   - Focused waveband or effective waveband of the detector should be adjusted flexibly to avoid negative edge effects.

- Statistical results:
  - Statistical method: 1) Normalize spectra of each comet.
  - Select the strongest 30 predicted EUV emission lines for each comet.
  - Superpose selected emission lines with their normalized values.
  - Discussion with a laboratory: Several wavebands were suggested and are marked with gray dashed lines in the statistical graph.

**Reference**

2. (2004) Li, Gu et al., Comets II, 631643
4. Bodewits et al., 2012, Astronomische Nachrichten, 333, 335
5. Gu et al., 2016, A&A, 588, 525