

I am an astrophysicist

I work mainly on massive stars,  
especially their radiation-driven winds

I study them mainly with X-ray spectroscopy



*HST: Carina Nebula*

Prof. David Cohen: SC 125/124

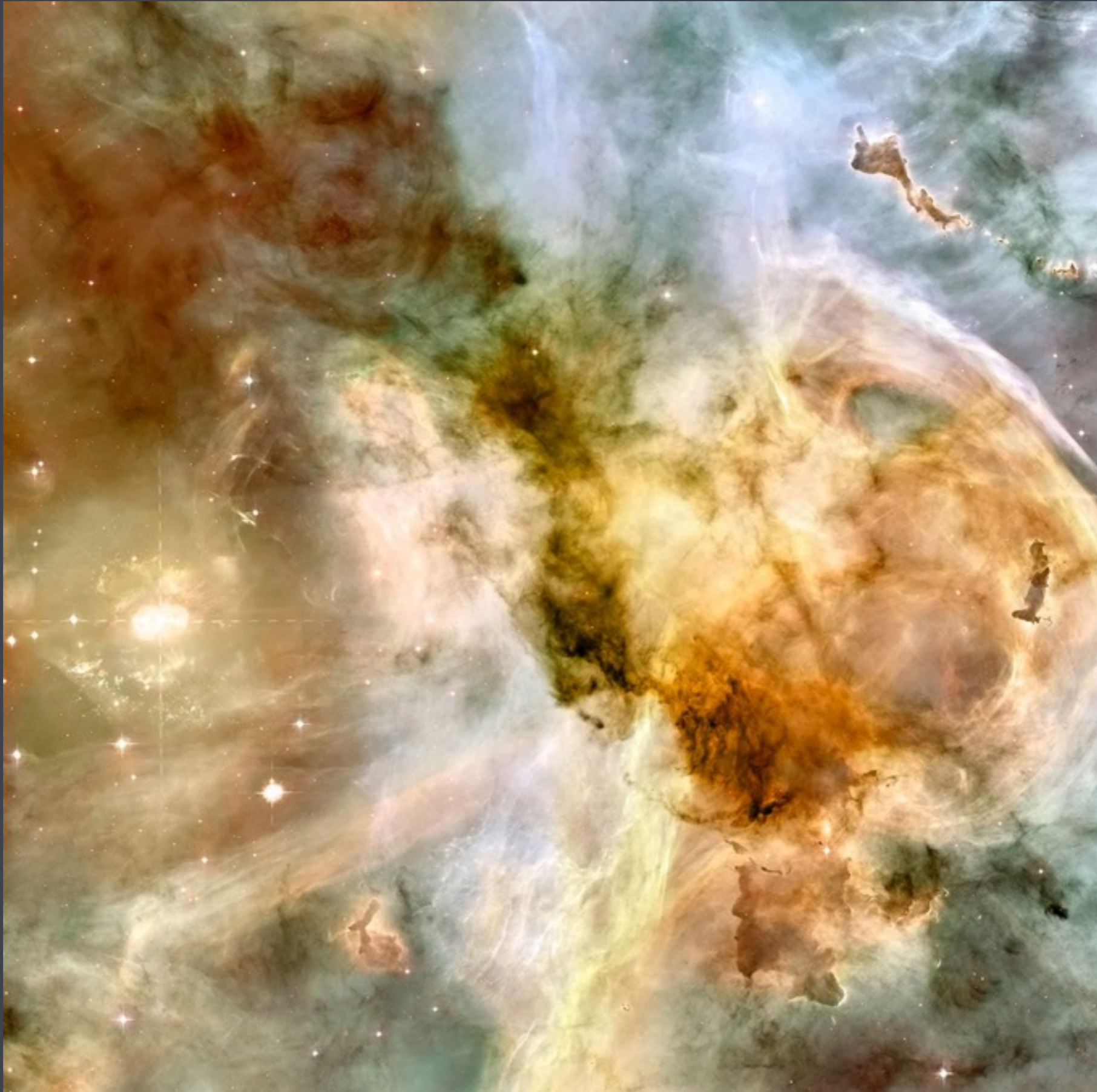
*Carina Nebula: star formation region,  $d \sim 7000$  light years*



*HST: Carina Nebula*

**Prof. David Cohen: SC 125/124**

energized by the few dozen most massive & luminous stars



*HST: Carina Nebula*

massive stars produce heavy elements and return them to the Galaxy via their stellar winds

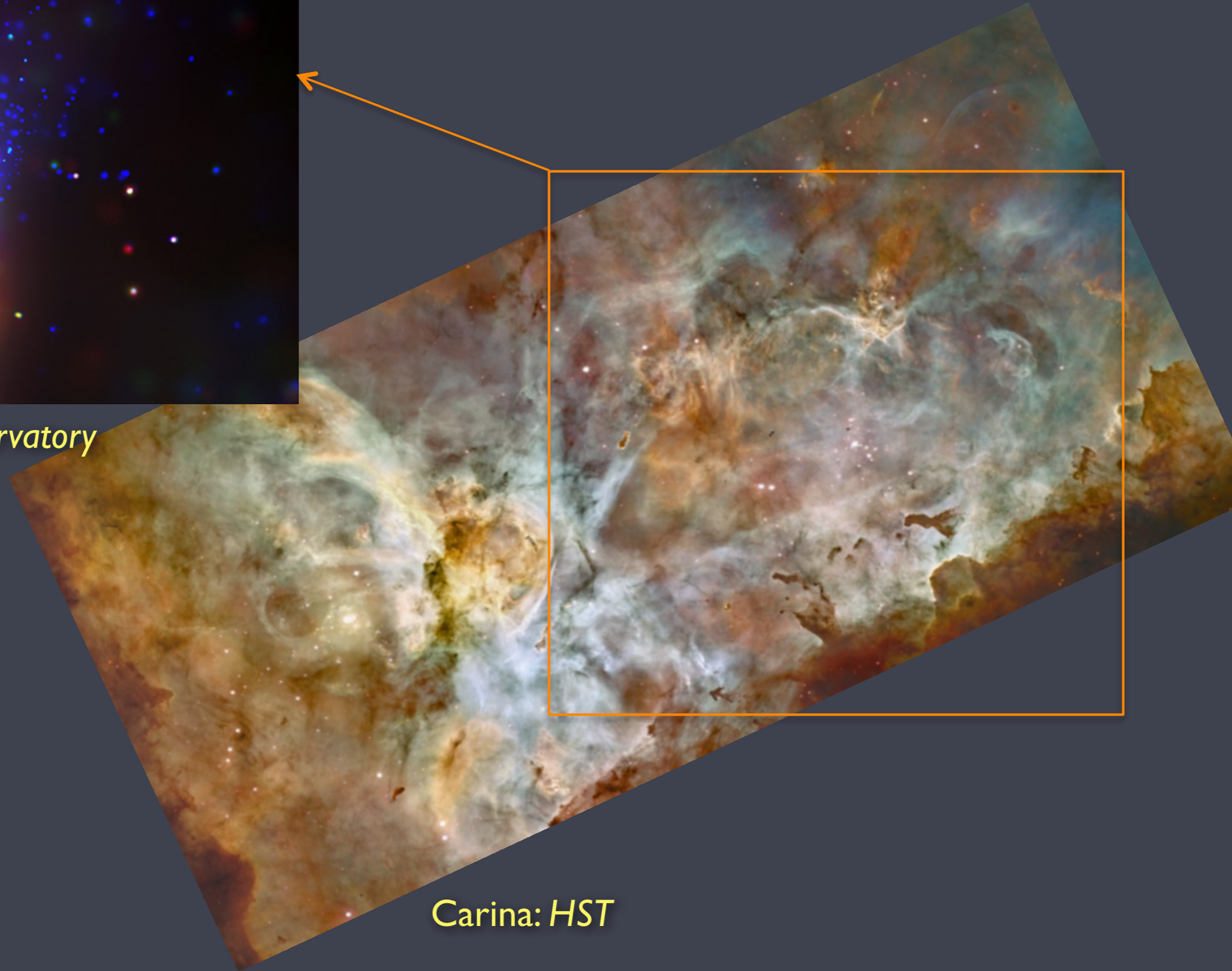


*eta Carina*

The massive stars are also strong X-ray sources



Tr 14: Chandra X-ray Observatory



Carina: HST

## ***Chandra* X-ray spectroscopy of the very early O supergiant HD 93129A: constraints on wind shocks and the mass-loss rate**

David H. Cohen,<sup>1\*</sup> Marc Gagné,<sup>2</sup> Maurice A. Leutenegger,<sup>3,4</sup> James P. MacArthur,<sup>1</sup>  
Emma E. Wollman,<sup>1,5</sup> Jon O. Sundqvist,<sup>6</sup> Alex W. Fullerton<sup>7</sup> and Stanley P. Owocki<sup>6</sup>

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<sup>2</sup>*Department of Geology and Astronomy, West Chester University, West Chester, PA 19383, USA*

<sup>3</sup>*NASA/Goddard Space Flight Center, Code 662, Greenbelt, MD 20771, USA*

<sup>4</sup>*CRESST and University of Maryland, Baltimore County, MD 21250, USA*

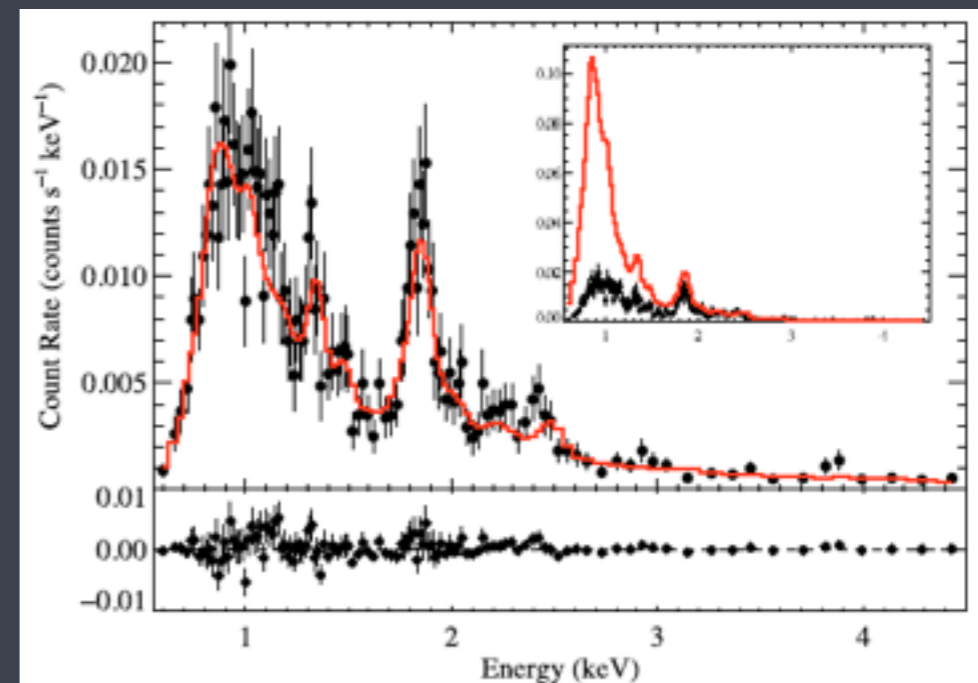
<sup>5</sup>*Department of Physics, Caltech, 1200 East California Boulevard, Pasadena, CA 91125, USA*

<sup>6</sup>*Bartol Research Institute, University of Delaware, Newark, DE 19716, USA*

<sup>7</sup>*Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA*



X-ray spectroscopy of the most massive star in the cluster provides new information about this star's wind



Tr 14 in Carina: *Chandra* X-ray Observatory

I work with a medium-sized group of scientists and students  
(Swarthmore, U. Delaware, Goddard Spaceflight Center,  
Space Telescope Science Institute, U. Leuven)

We have group meetings to do our work, we go to  
professional meetings to present our work



Erin Martell, Emma Wollman '09

I am looking for ~2 students who know Python and want to start working this spring (and then 8 weeks during the summer)

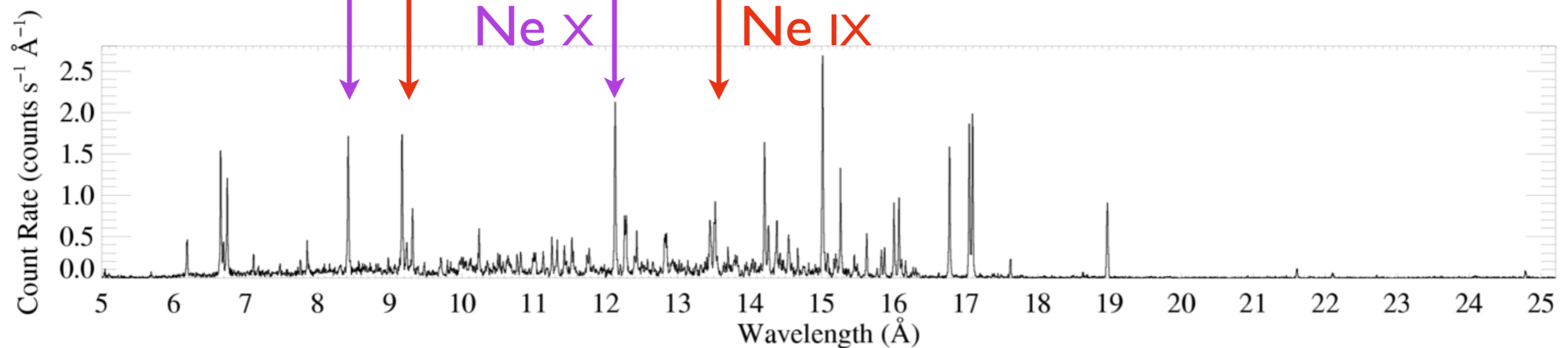
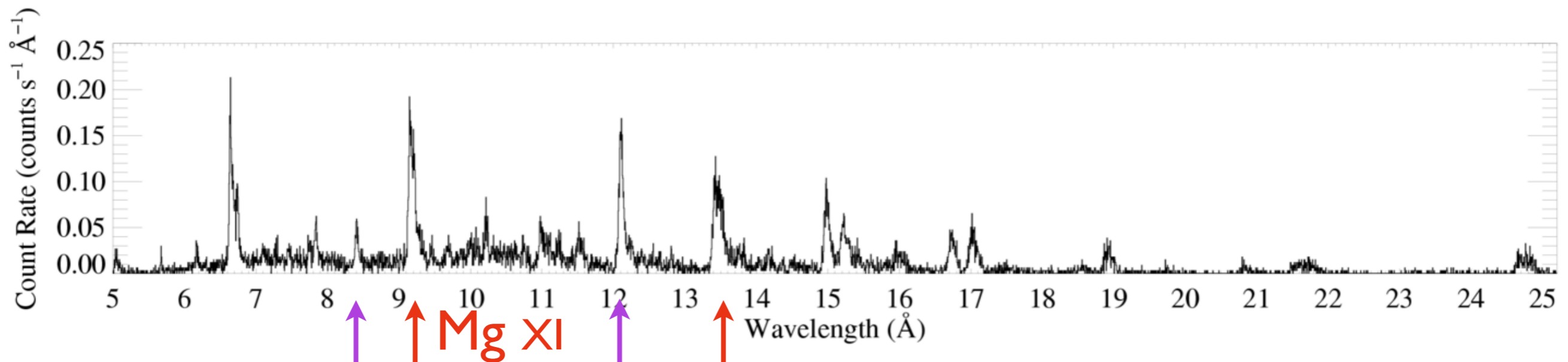
We have some interesting X-ray spectra: of zeta Pup and theta I Ori C



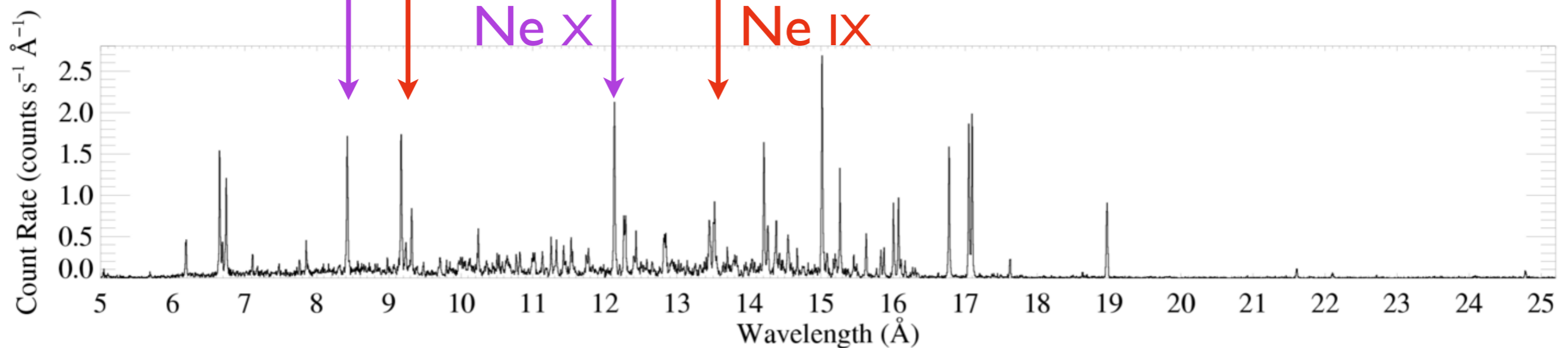
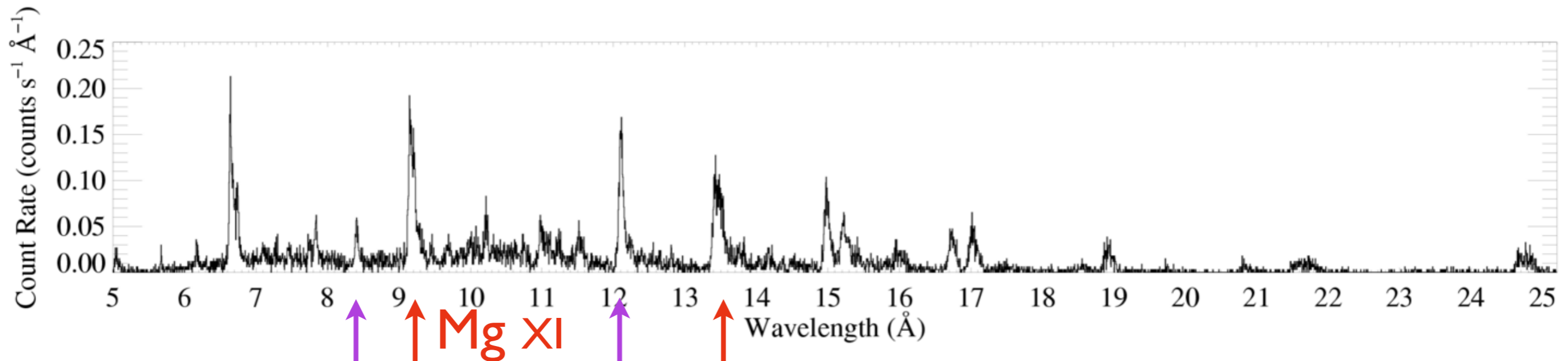


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We have some interesting X-ray spectra: of zeta Pup and theta I Ori C



Scientific questions: What do the emission line shapes tell us about the kinematics of the hot wind plasma (why are one star's lines narrow and the other's broad?); What can we learn about the plasma temperature distribution? The chemical elements present in the plasma?



# more information on my website

astro.swarthmore.edu/~cohen

all faculty websites are listed on the dept site

this presentation

## Student Research Group

Sophia Lin ('19) joined the massive star X-ray group this spring and Jackie Pezzato ('17) has graduated and will be attending the Astronomy PhD program at Caltech in the fall.

Zack Li and David Lazere graduated in 2016, going on to grad school at Princeton and to work for an anti-hunger non-profit, respectively. Jackie Pezzato ('17) and Sarah Rubinstein ('19) are continuing to work on projects involving X-ray spectroscopy of massive stars, and they are joined by new group members Nathaniel Peters ('18) and Li Tian ('18) for the 2016-17 academic year.

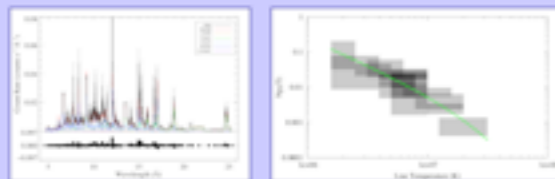
In the summer of 2014, Jackie Pezzato ('17) and Randy Doyle ('16) worked with me on projects involving the interpretation of X-ray spectra of massive stars. I presented some of their preliminary results at a meeting in 2014.



In December 2017, I gave a presentation about my group's massive star research to inform students about our research and about opportunities to join the research group. I will likely be taking new students for the summer of 2017, with work to start during the spring semester. Come and talk to me if you think you might be interested.

### Summer Research 2013

Zack Li and Kelley Langhans, both rising sophomores, are working on different aspects of the problems of measuring and modeling the plasma temperature distribution in the shock-heated winds of massive stars.



### Summer Research 2012

Astrophysics major Jake Neely ('13) has been working on a project to analyze the X-ray line emission in the O stars  $\zeta$  Ori and  $\zeta$  Pup, as measured with the Reflection Grating Spectrometer on the XMM X-ray Telescope. Jake is using these data to derive elemental abundances in these massive stars winds, and address questions related to rotational mixing and chemical evolution in O stars.

### Summer Research 2011

## Research Information

**Astrobetter** – lots of useful information about the nitty-gritty of astronomical research and many aspects of being an astronomy student and astronomer

**Astrobites** – very short summaries of interesting research papers, written for undergraduates by graduate students; an excellent way to browse the literature or find articles on a given topic

**Astronomy Image Explorer** – images from refereed papers; browsable and searchable; a good (fun) way to browse papers

**AAS Nova** – image-based research highlights from AAS journals

## Practical, for Group Members

Local computing information

- ADS
- astro-ph
- SIMBAD
- Astronomical Catalogs
- Chandra X-ray Center
- XMM Guest Observer Facility
- HEASARC
- ATOMDB atomic database
- XSPEC manual

Tutorial on *thermal radiation processes*, by J. Kaastra. A good (but somewhat technical) place to start answering the question *Why do these X-ray spectra look the way they do?*

## Graphics

- Historical graphics
- Edward Tufte
- Visualizing Astronomy at the CFA
- Information Aesthetics
- Flowing Data

## Student Travel and Research Funding

HHMI travel funding  
Sigma Xi travel funding  
(these two will fund travel to meetings)

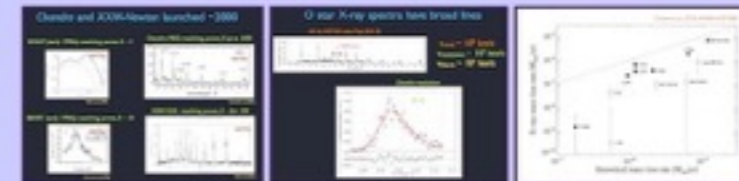
Soffen Memorial Fund  
(they fund travel to meetings)  
Sigma Xi grants in aid of research  
National Geographic Young Explorers  
(things like travel to an observatory are eligible)

## Recent Presentations

Many of these presentations involve student research. You can get information about student research in the Department of Physics and Astronomy here at Swarthmore College. You can also see what else my research group is up to.

Refereed papers are archived here.

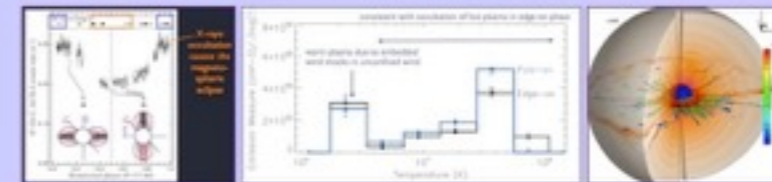
I gave an invited talk on X-ray spectroscopy of stellar winds [pdf] at the *Universe in High-Resolution X-ray Spectra* at Harvard in August 2015.



I gave a talk at the Harvard CFA Solar, Stellar, and Planetary Sciences Division's weekly seminar on the new work I did with Zack Li on using X-ray spectra to determine the O star wind shock heating rate [pdf].



For the *festschrift* of my friend Huib Heerichs, in Amsterdam in September 2014, I gave an invited talk on new X-ray observations of the prototype magnetic O star, theta1 Ori C [pdf].



In September, 2013 I gave the Astronomy Department colloquium at Penn State, entitled "X-ray Spectroscopy of O Supergiant Winds: Shock Physics, Clumping, and Mass-Loss Rates" [pdf].