Python Bootcamp: Afternoon Sessions

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UC Santa Cruz
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About me

Giving a talk about my research in Greece

- Originally from LA… (San Fernando Valley)
- Went to community college at Pierce College in LA. Took night courses while working full time.
- Transferred to UC Berkeley - degree in Physics & Astrophysics
- Undergraduate internships at UC Davis & NASA Jet Propulsion Laboratory
- 5th year graduate student in Astronomy & Astrophysics at UCSC
- Use C++ and python programming languages in my research

Day 1 Outline

- Intro: Description and motivation for the use of computer programming in scientific research
- Programming Logic & Pseudocode
- Wrap-up Activity: Write your own pseudocode!

What is computer programming?

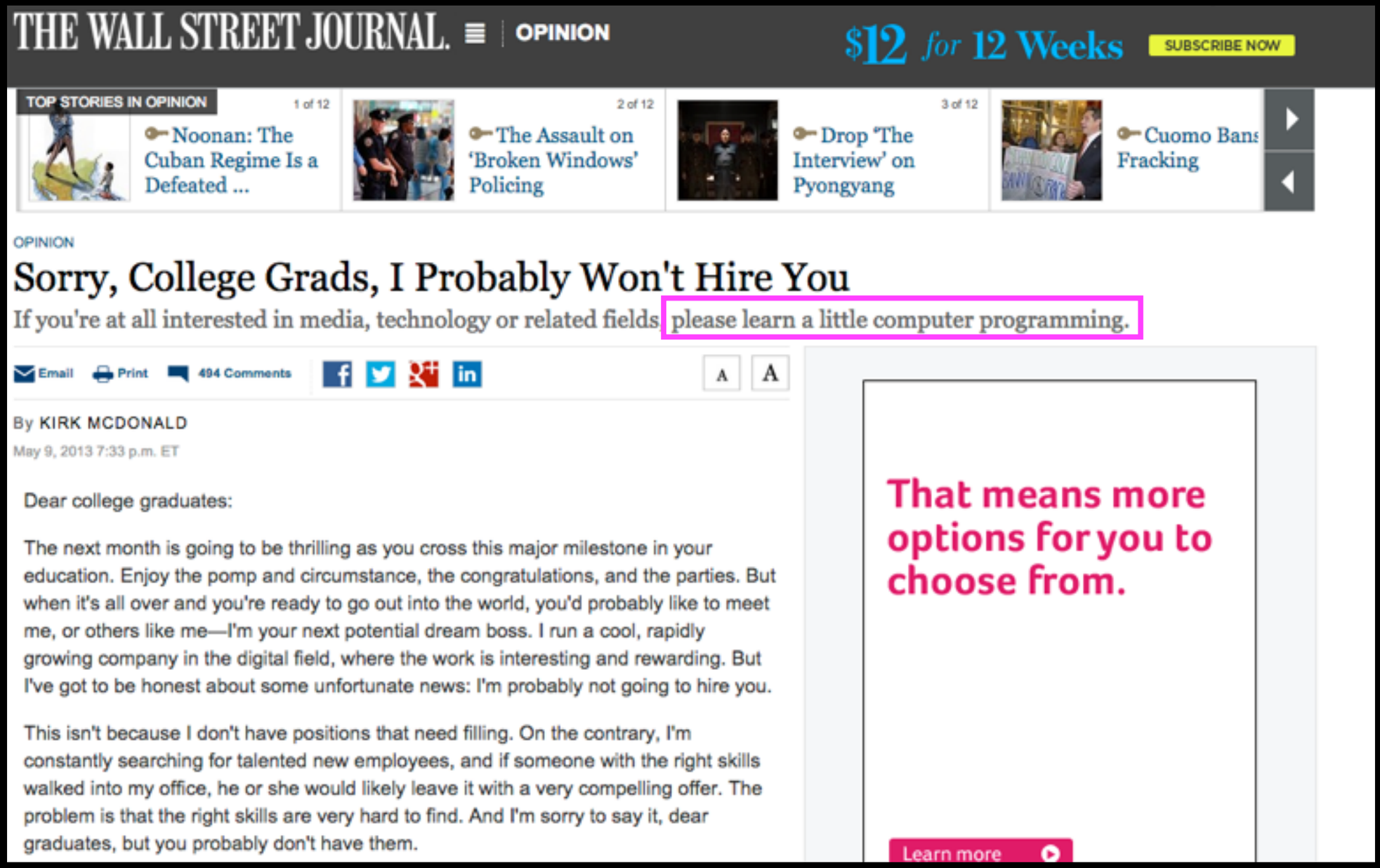
Computer programming (aka programming) is a process that leads from an original formulation of a computing problem to executable computer programs.

What is computer programming?

Programming uses algorithms (i.e., step-by-step procedures used for calculations).

These algorithms are used for calculation, data processing, data visualization, and automated reasoning.

Why everyone should love (and know) computer programming



"If you want to survive in this economy, you'd be well advised to learn how to speak computer code."

Courtesy of Jill Naiman

Why astrophysicists love (and MUST know) computer programming

History Lesson: Harvard computers

Edward Charles Pickering, director of Harvard Observatory, hired women to process astronomical data.

These “computers” catalogued and analyzed stellar spectra by eye to create a classification system for stars.

Harvard “computers”, circa. 1892 (wikipedia)

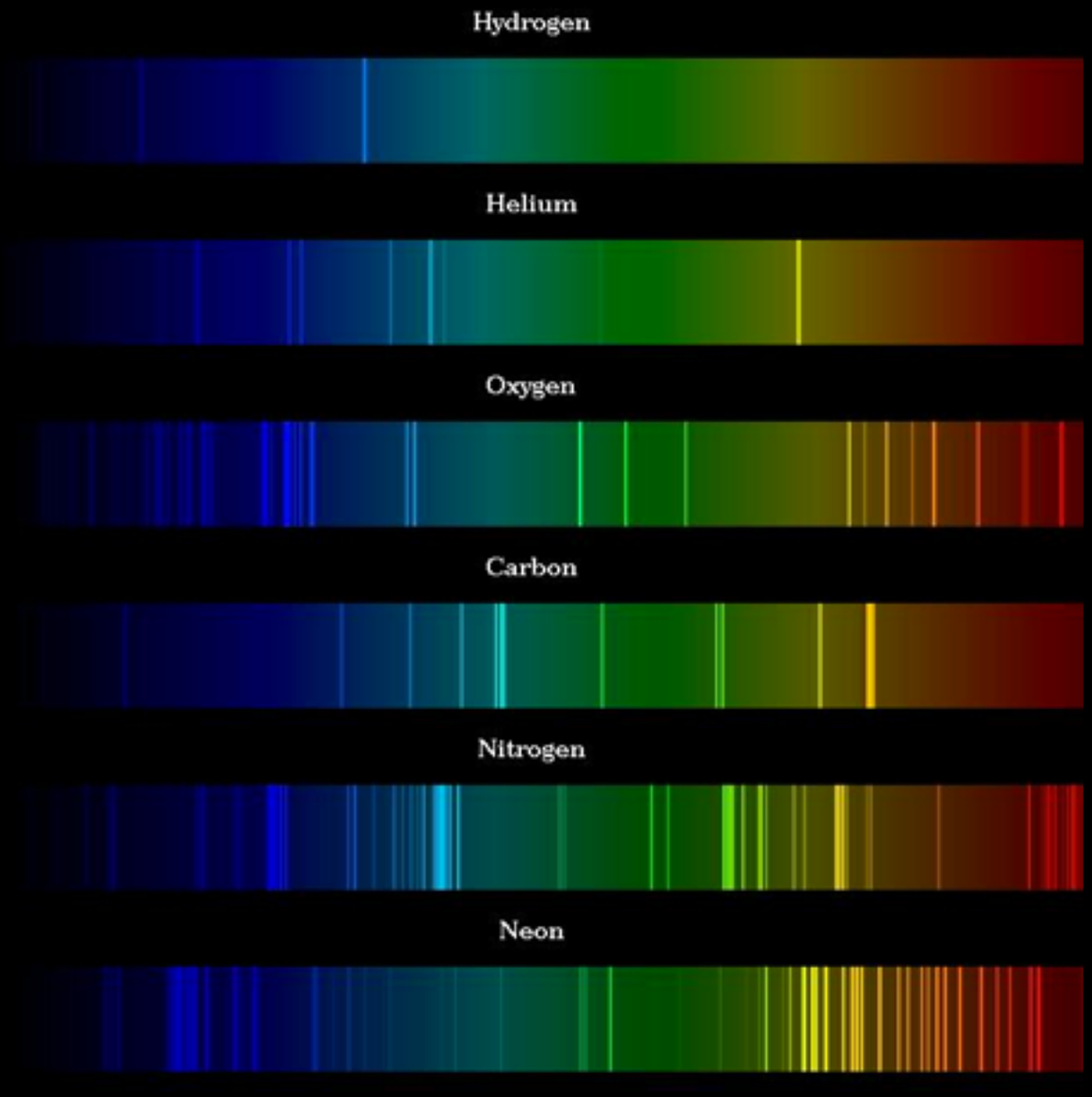
As technology advances, the amount of data we receive increases drastically. Would you want to analyze this data by eye?

Data Processing Example: Atomic Spectra

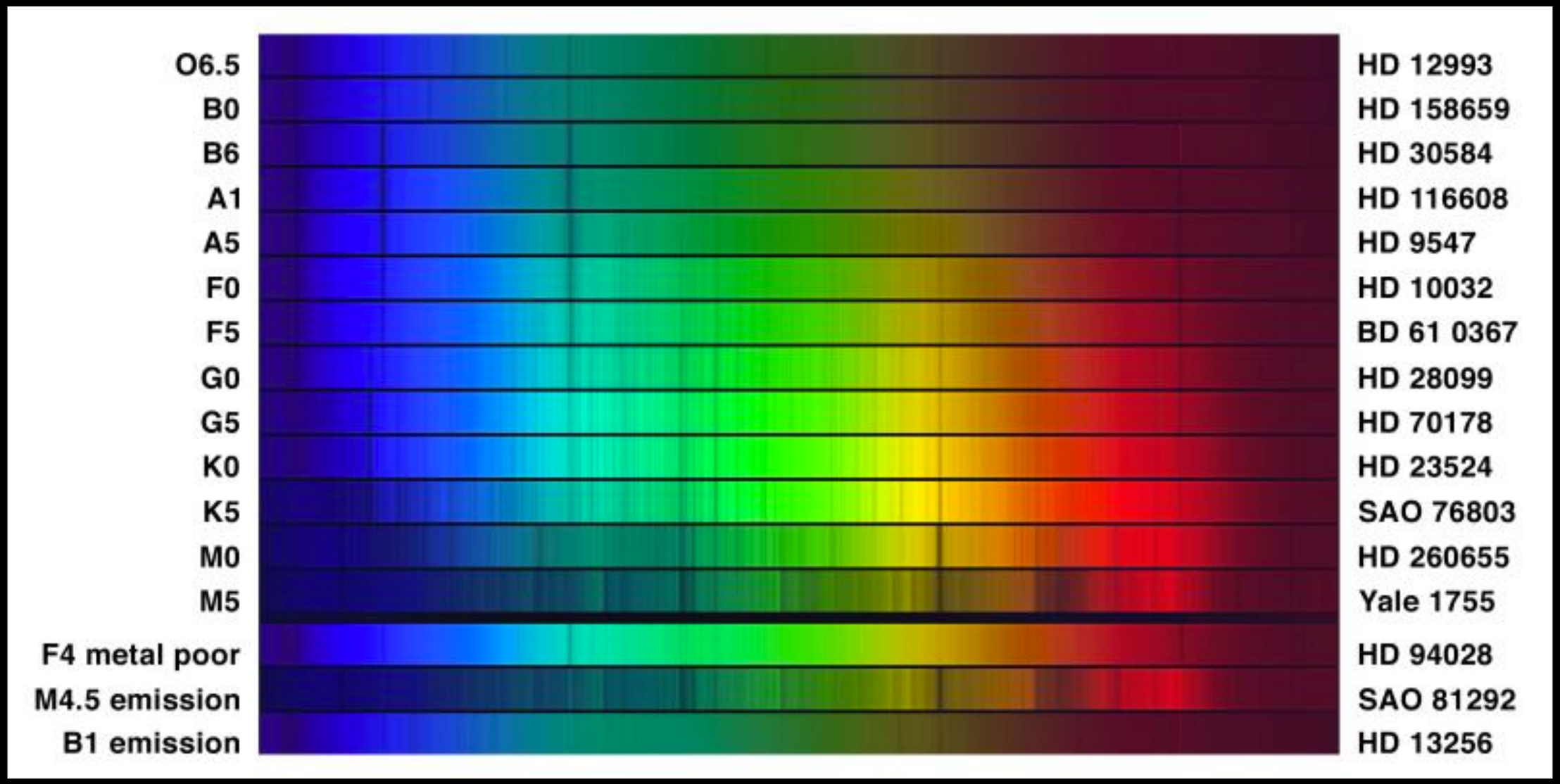
Different atoms emit/absorb light at specific frequencies related to their internal structure.

Emitted/absorbed light for many different atoms results in a emission/absorption spectrum.

Astronomers study spectra of objects such as stars to determine their age, mass, temperature, composition, etc.



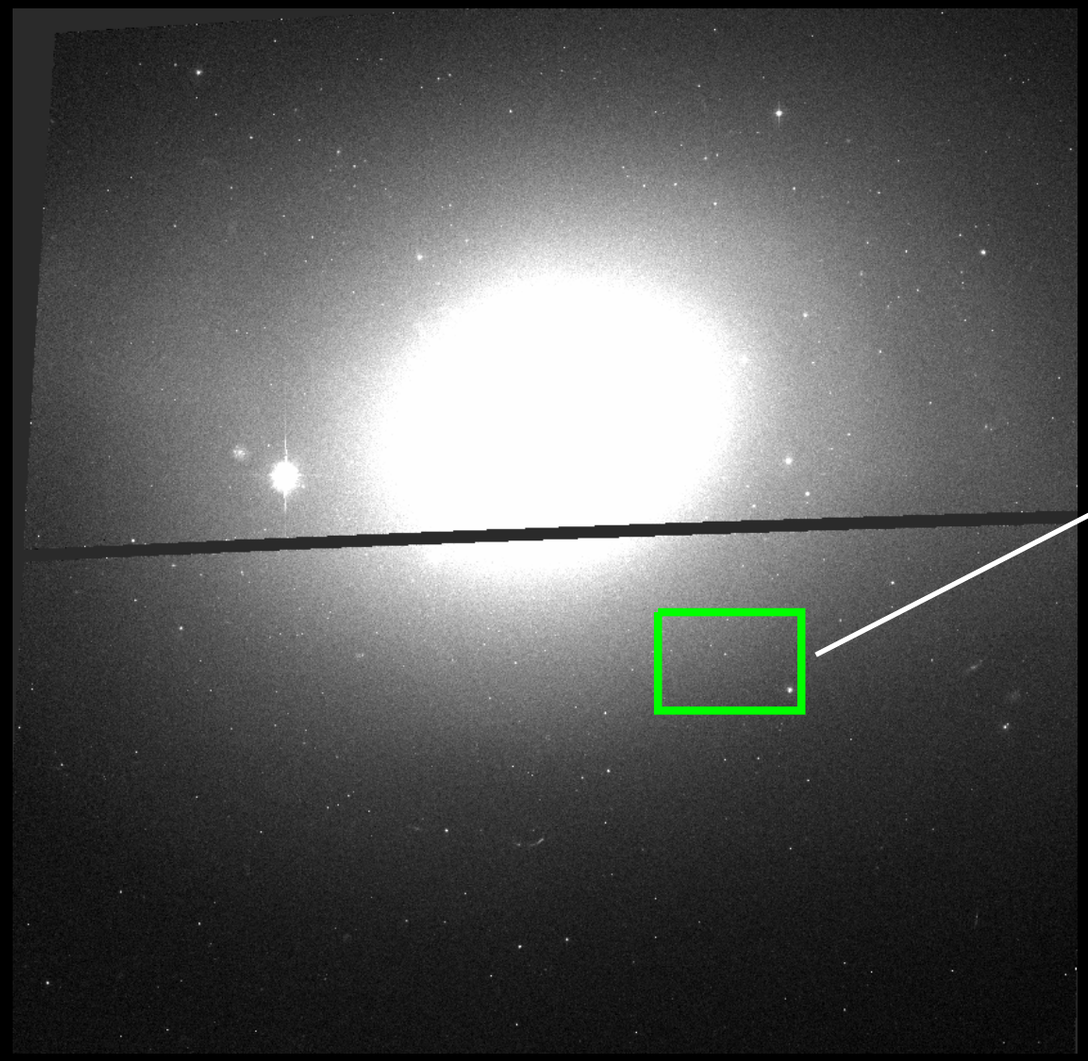
Harvard Stellar Classification System



Absorption lines from different elements depend on the star's surface temperature and chemical composition.

Astronomers use programming to organize, clean/reduce, analyze, and visualize data.

Astronomical Image Data Reduction/Post-processing



Mosaic Hubble image of galaxy M85
located in the Virgo Galaxy Cluster

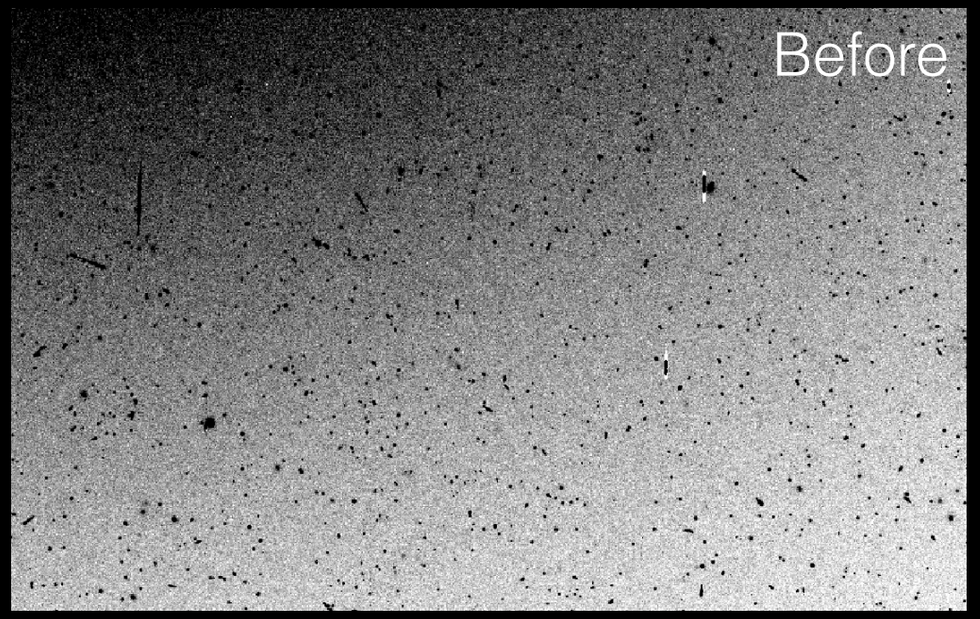


Image corrected for distortion and cosmic rays

Images courtesy of Zach Jennings

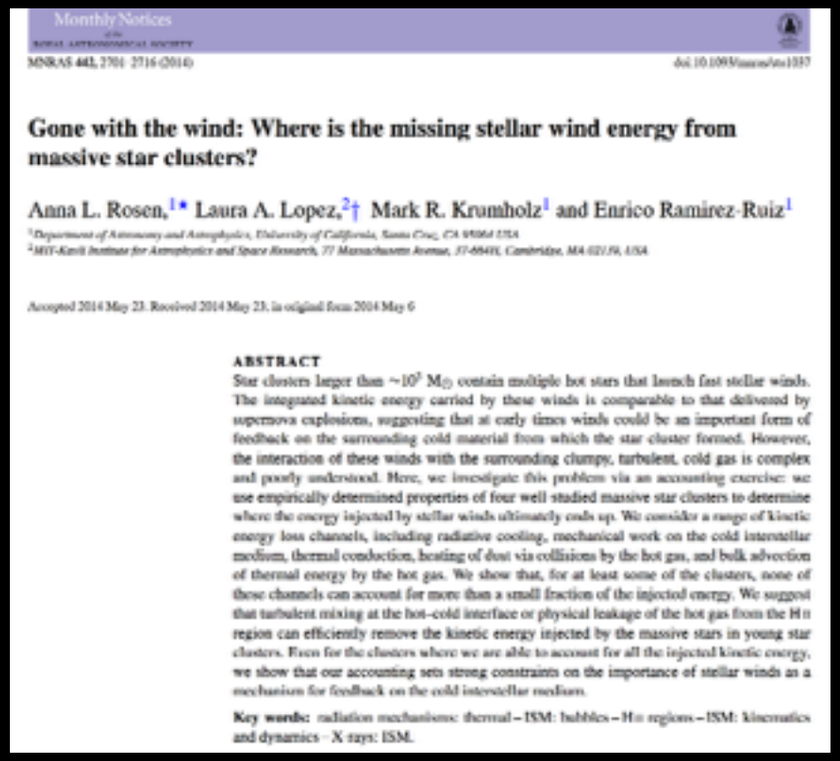
Why

python?

What Python is…

- Python is a multi-paradigm programming language
  - Supports procedural and object oriented programming
- Takes care of memory management behind the scenes
- Code syntax is easily readable
- Good programming practices are enforced (i.e., indentation)
- Has large online community, libraries, and online docs
- FREE!

How I use Python in my everyday research



Monthly Notices

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Gone with the wind: Where is the missing stellar wind energy from massive star clusters?

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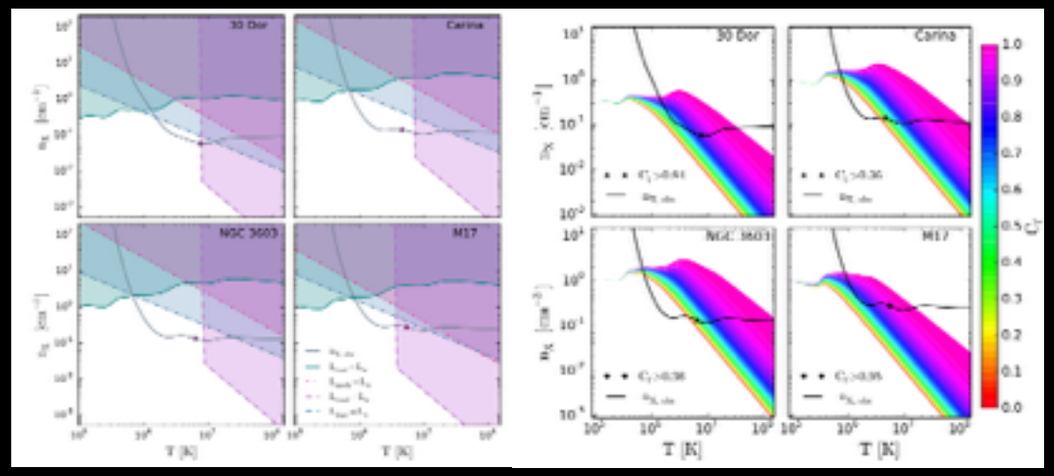
ABSTRACT

Star clusters larger than $\sim 10^5$ $M_\odot$ contain multiple hot stars that launch fast stellar winds. The integrated kinetic energy carried by these winds is comparable to that delivered by supernova explosions, suggesting that at early times winds could be an important form of feedback on the surrounding cold material from which the star cluster formed. However, the interaction of these winds with the surrounding clumpy, turbulent, cold gas is complex and poorly understood. Here, we investigate this problem via an accounting exercise: we use empirically determined properties of four well studied massive star clusters to determine where the energy injected by stellar winds ultimately ends up. We consider a range of kinetic energy loss channels, including radiative cooling, mechanical work on the cold interstellar medium, thermal conduction, heating of dust via collisions by the hot gas, and bulk advection of thermal energy by the hot gas. We show that, for at least some of the clusters, none of these channels can account for more than a small fraction of the injected energy. We suggest that turbulent mixing at the hot–cold interface or physical leakage of the hot gas from the H II region can efficiently remove the kinetic energy injected by the massive stars in young star clusters. Even for the clusters where we are able to account for all the injected kinetic energy, we show that our accounting sets strong constraints on the importance of stellar winds as a mechanism for feedback on the cold interstellar medium.

Key words: radiation mechanisms: thermal – ISM: bubbles – H II regions – ISM: kinematics and dynamics – X-rays: ISM.



Research for this paper was completely done in Python

Visualize numerical simulation data using a python package called *yt* developed by astronomers