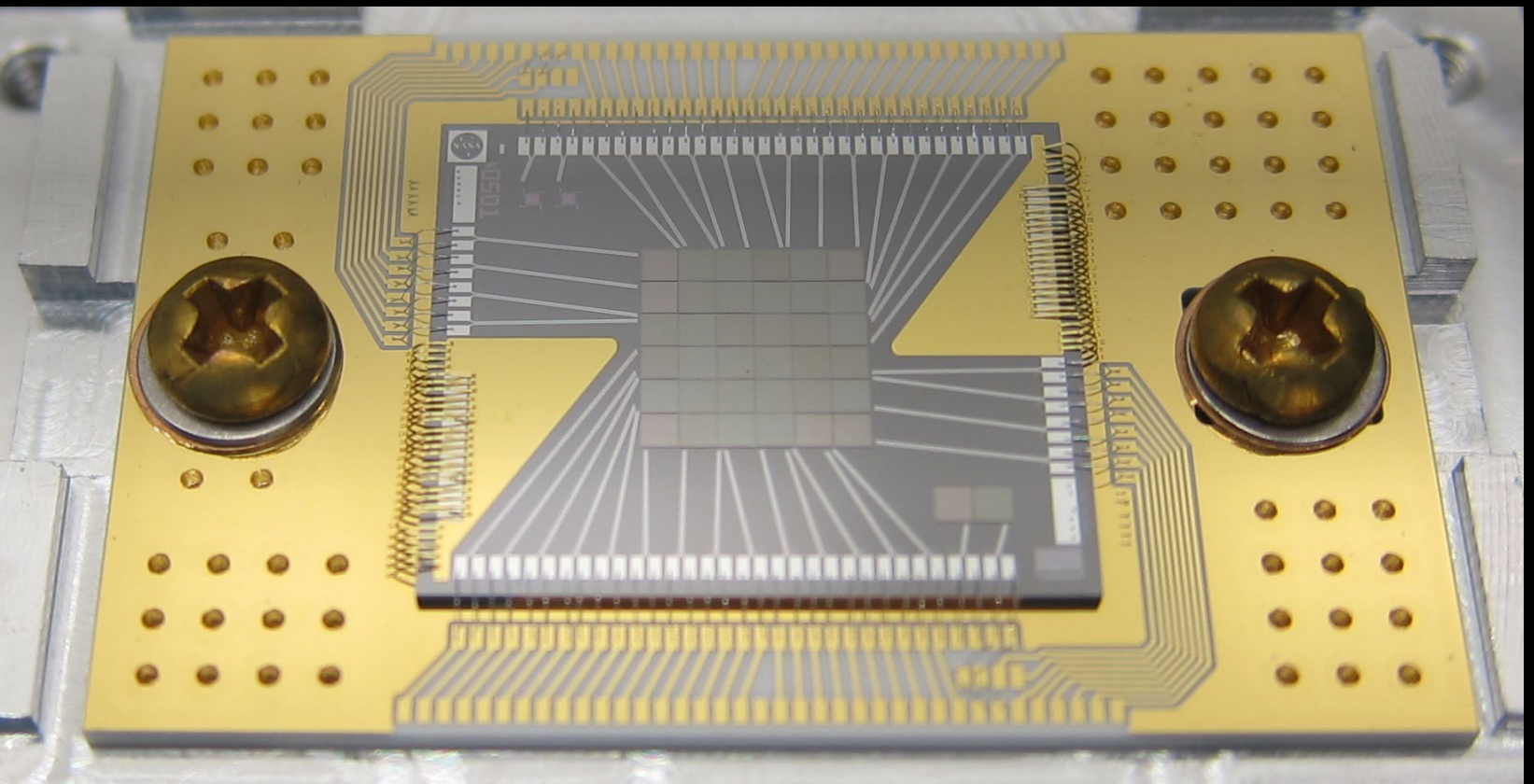
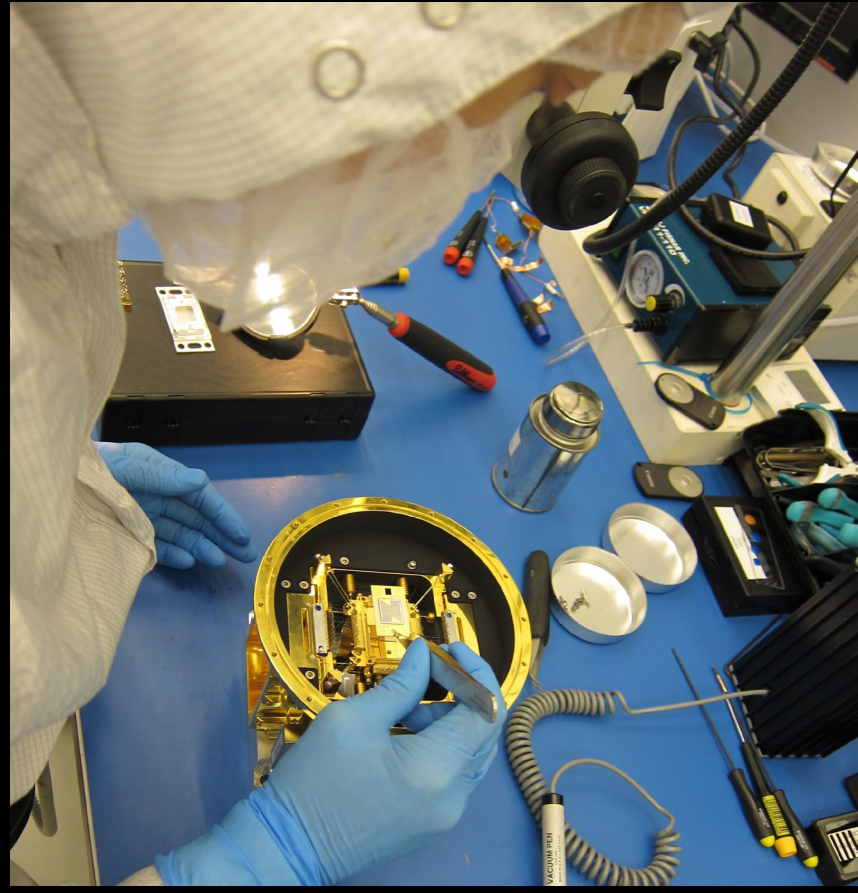
Career Spotlight: Developing, implementing, and using new technology for NASA astrophysics missions





Caroline Kilbourne – NASA GSFC

NASA Physics of the Cosmos Early-Career Workshop

Day 3: Careers

November 21, 2024

What is my job and my role?

- I am a senior* scientist in the X-ray Astrophysics Laboratory at NASA's Goddard Space Flight Center. (* Started as post-doc in 1992; hired in 1995)
- I am a physicist with very broad interests^. (^ This has been essential!)
- Throughout my career at Goddard, I've been developing microcalorimeter arrays for high-resolution X-ray spectroscopy and supporting technology needed to make microcalorimeter instruments, and I've been working on various system issues important to realizing space-worthy spectrometers.

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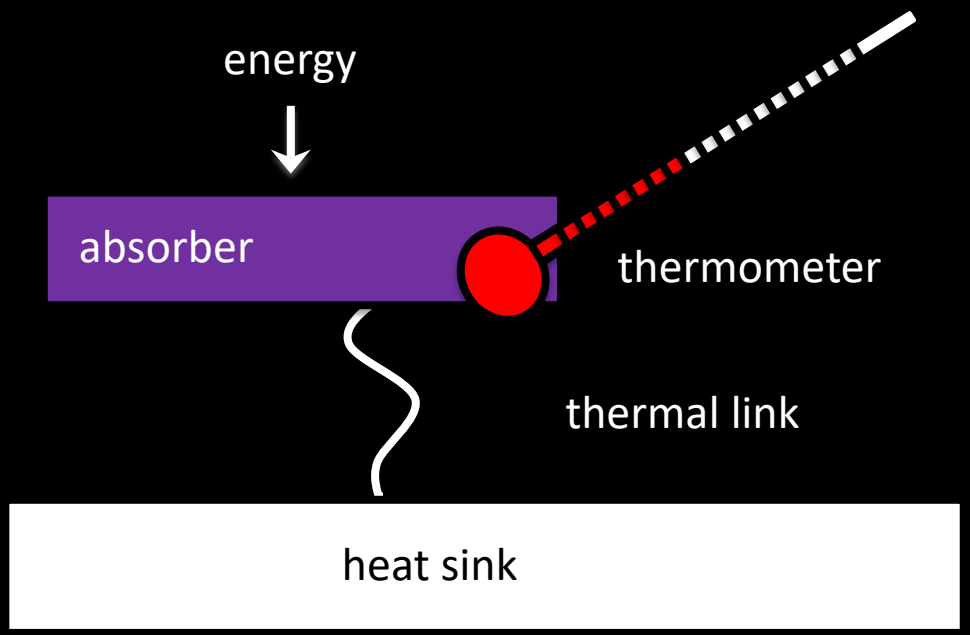
But… what's a microcalorimeter?

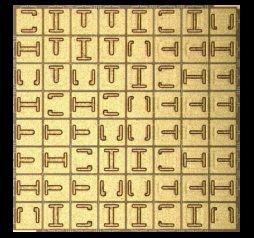
What is an X-ray microcalorimeter?



- collector of the incident radiation
  - Absorbs individual X-ray photons and thermalizes them
- sensitive thermometer
- thermal link to a heat sink
- Basic concept can be tailored to mission requirements

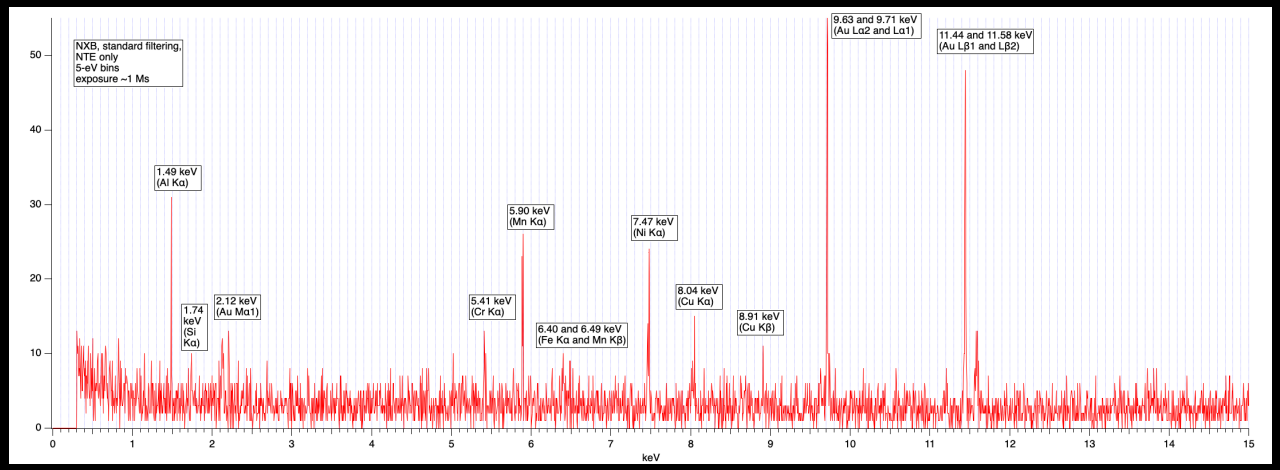
- The ultimate energy resolution is determined by how well one can measure this change in temperature against a background of temperature fluctuations.
- Low-temperature (< 0.1 K) operation is required to minimize these thermodynamic energy fluctuations and to reduce the heat capacity.

What has the job entailed?



- PI of series of funded technology development proposals/programs
- Delivering subsystem flight hardware to next level of integration for Astro-E, Astro-E2, Astro-H (Hitomi), and XRISM (and several sounding rockets).
- Input to designs of other subsystems and data processing algorithms
- One of the instrument scientists for Astro-H and XRISM
  - Most of my time currently spent on the XRISM data
- Engaged in various attempts to create future high-spectral-resolution imaging spectrometer missions

LEM



How did I get here?

- When I started grad school, I never expected to have anything to do with low-temperature physics or astrophysics.
- I was a DOE baby...
  - Did summer internships at SLAC and Brookhaven
  - Joined the research group of Arthur Bienenstock, then director of SSRL
  - Was tracking towards a career in condensed matter research using synchrotron measurement techniques.

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WHAT HAPPENED?

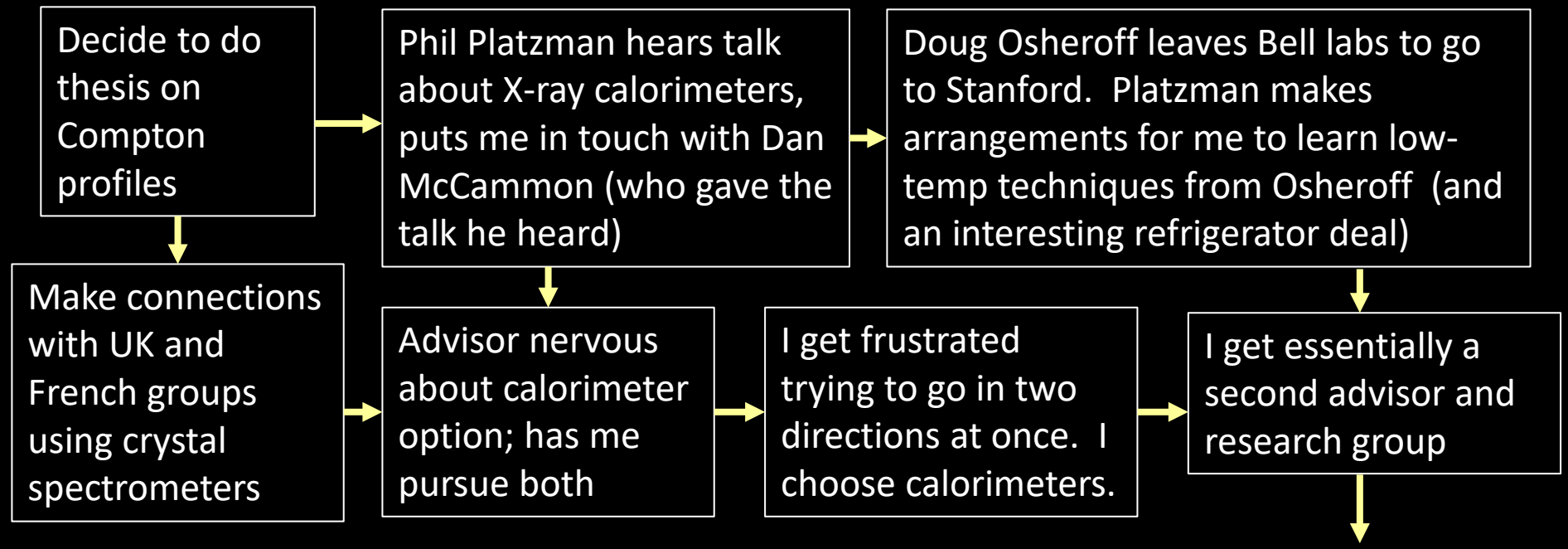
One approach to grad school….

- Have a guiding plan but maintain 4π awareness for new ideas!
- Don’t limit yourself to the options obviously before you
  - Asking if something else is possible just might create an amazing opportunity
- If an extraordinary opportunity presents itself, but it takes you outside of your comfort zone, go for it. Think of how much more you can learn! And it just might set off a chain reaction of extraordinary opportunities!

One approach to grad school….

- For me, it started with a meeting with my advisor to talk about potential thesis topics. I don't remember the exact topics he suggested, but they all had to do with structure in materials, possibly associated with phase transitions, studied with X-ray scattering techniques.
- Instead of inquiring about the topics he mentioned, I asked whether X-rays could be used to study electronic structure. To which he replied:
  - "Phil Platzman at Bell Labs has been urging me to get a student working on Compton scattering measurement of electron momentum distributions."
  - I read the literature, and got excited to be that student
  - But I was going to need a high-resolution spectrometer

One approach to grad school….

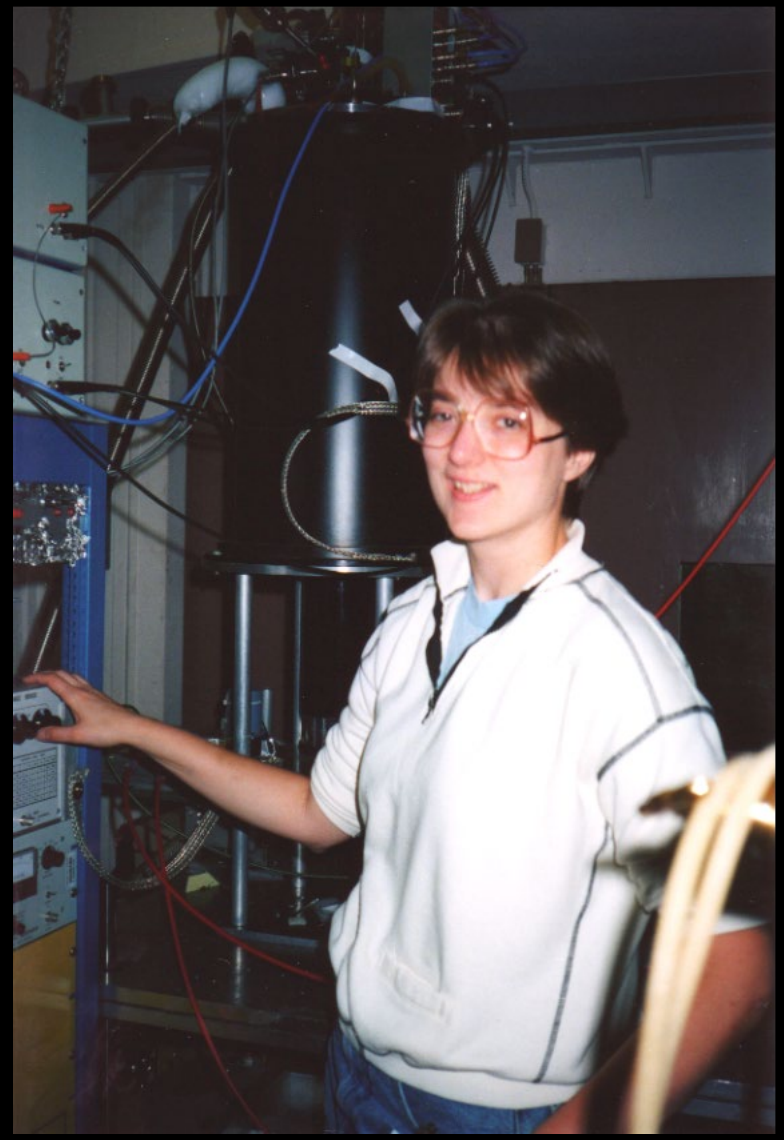


Before I know it, I'm managing the inputs of various experts (where is my advisor in all this?) Only I saw the whole picture.

- Compton measurements (Loupias, Cooper)
- Theory of Fermi surfaces (Platzman)
- Low temperature techniques (Osheroff)
- X-ray calorimeters (McCammon, Moseley, Kelley, Szymkowiak)
- Superconductivity (for absorbers for this hard X-ray application) (Platzman)
- Signal processing (McCammon, Szymkowiak)
- Low-noise electronics (McCammon)
- Synchrotron logistics (Brennan)

If I had known…

- If I had known exactly how my thesis topic was going to expand, I might not have chosen it
- I kept saying I wasn't the right person to be doing a project like that.
- However, the project transformed me into the right person to accomplish it.
- And for some reason, all my job opportunities out of grad school were for astrophysics instrumentation. Hmmm…
  - Wonderful! More physics to learn!



Parting thoughts

- Instrumentation skills transcend disciplines
- Project management skills transcend disciplines
- Non-standard experience is a superpower.
  - It can lead to insights that no one else can bring to a problem
- Cultivate 4π awareness
  - Opportunities
  - Connections
  - Patterns
  - Disruptions to patterns
- It's all just solving puzzles
  - Whether learning about the Universe, debugging software, figuring out the weird glitches in the data, or making a schedule that gets the hardware delivered on time
  - The job is much more enjoyable if you find joy in solving all the puzzles!