

MILLIMETER ASTRONOMICAL INSTRUMENTATION



Miranda Eiben

WHO AM I?

- Graduated Hudson High in 2014 (I took these engineering classes!)
- A mechanical engineer
 - I know a lot about motors, gears, materials, and how to design mechanical components
- An astrophysicist!
 - I use my mechanical know-how to make telescopes!
 - Currently an astrophysics graduate student at Harvard University

Telescopes at the South Pole!

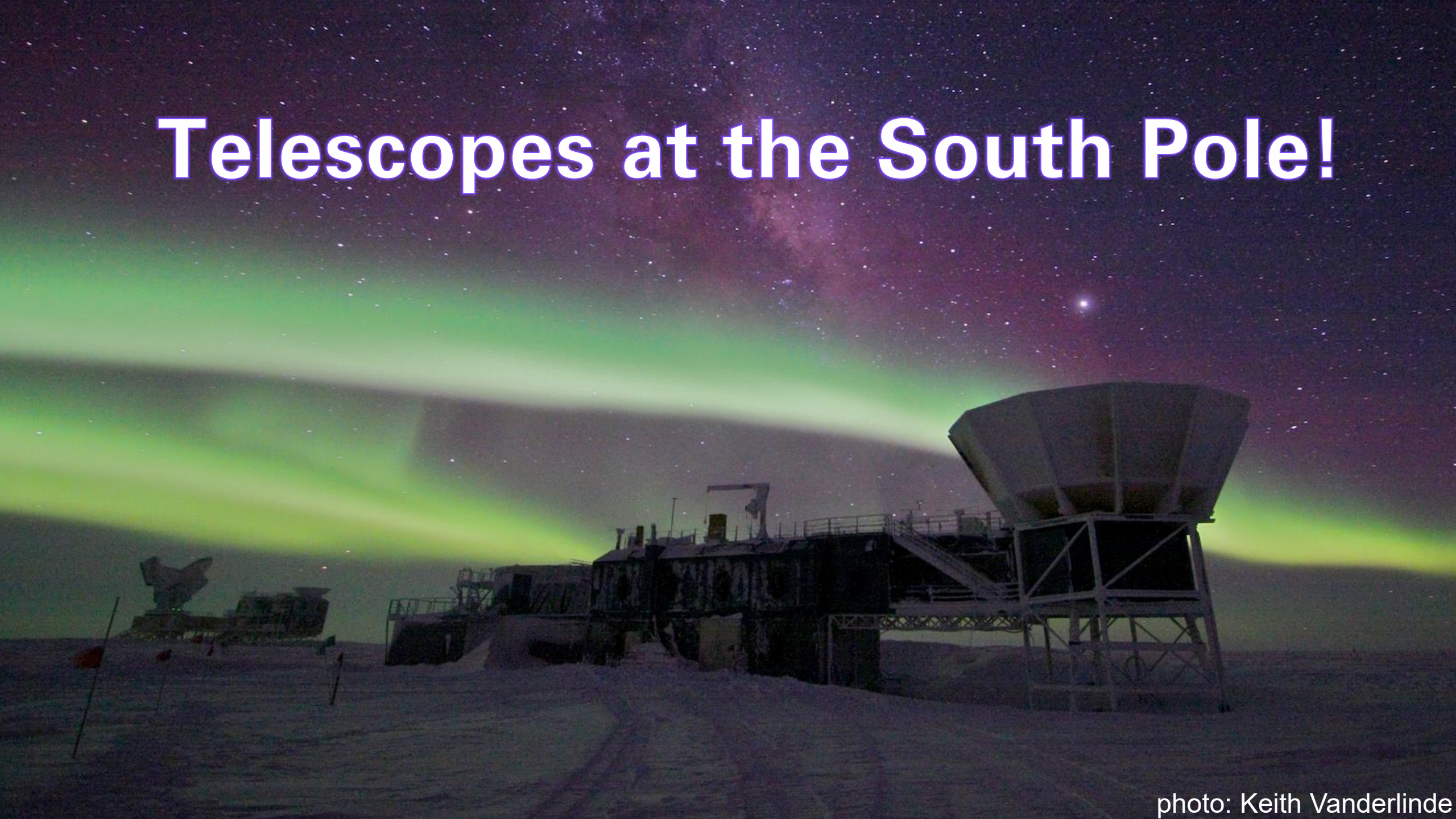
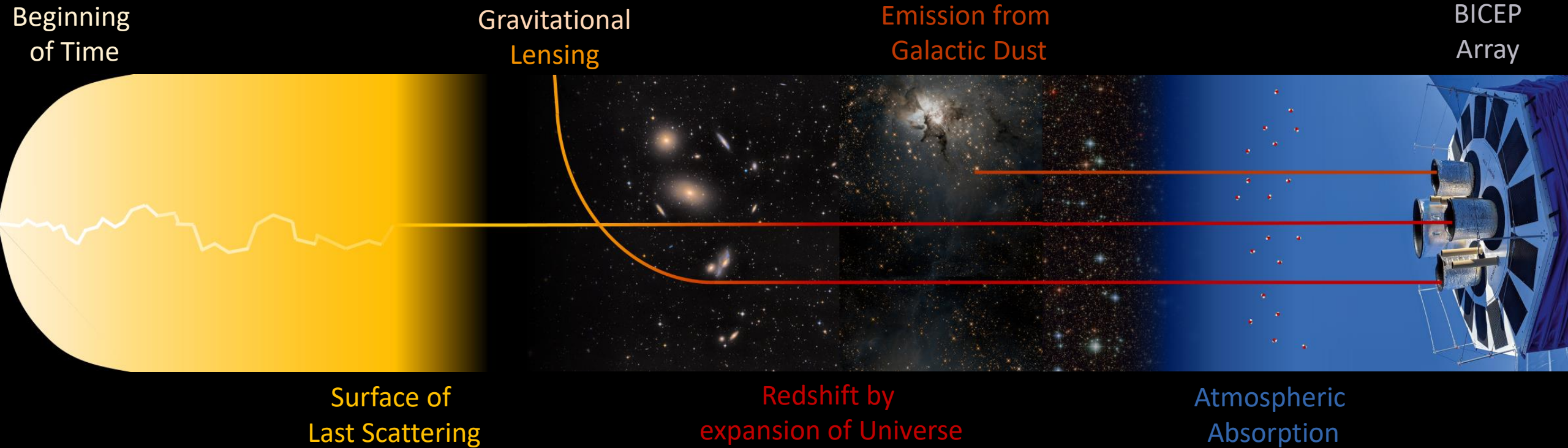


photo: Keith Vanderlinde

What are we looking at?



WHY GO ALL THE WAY TO ANTARCTICA?



We go from:

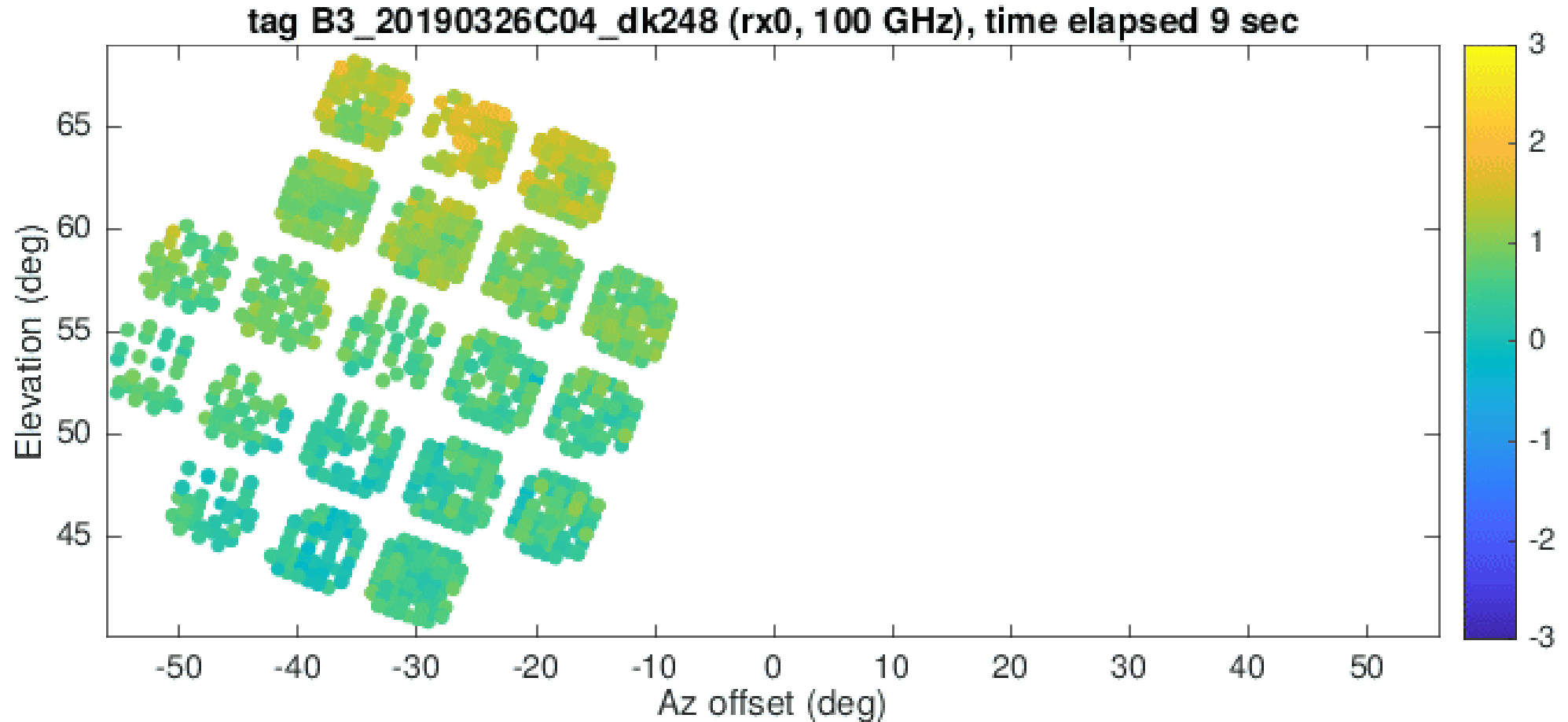
Boston to Christchurch, New Zealand (~10,000 miles)

Christchurch to McMurdo Station (~2,400 miles)

McMurdo Station to South Pole Station (~850 miles)

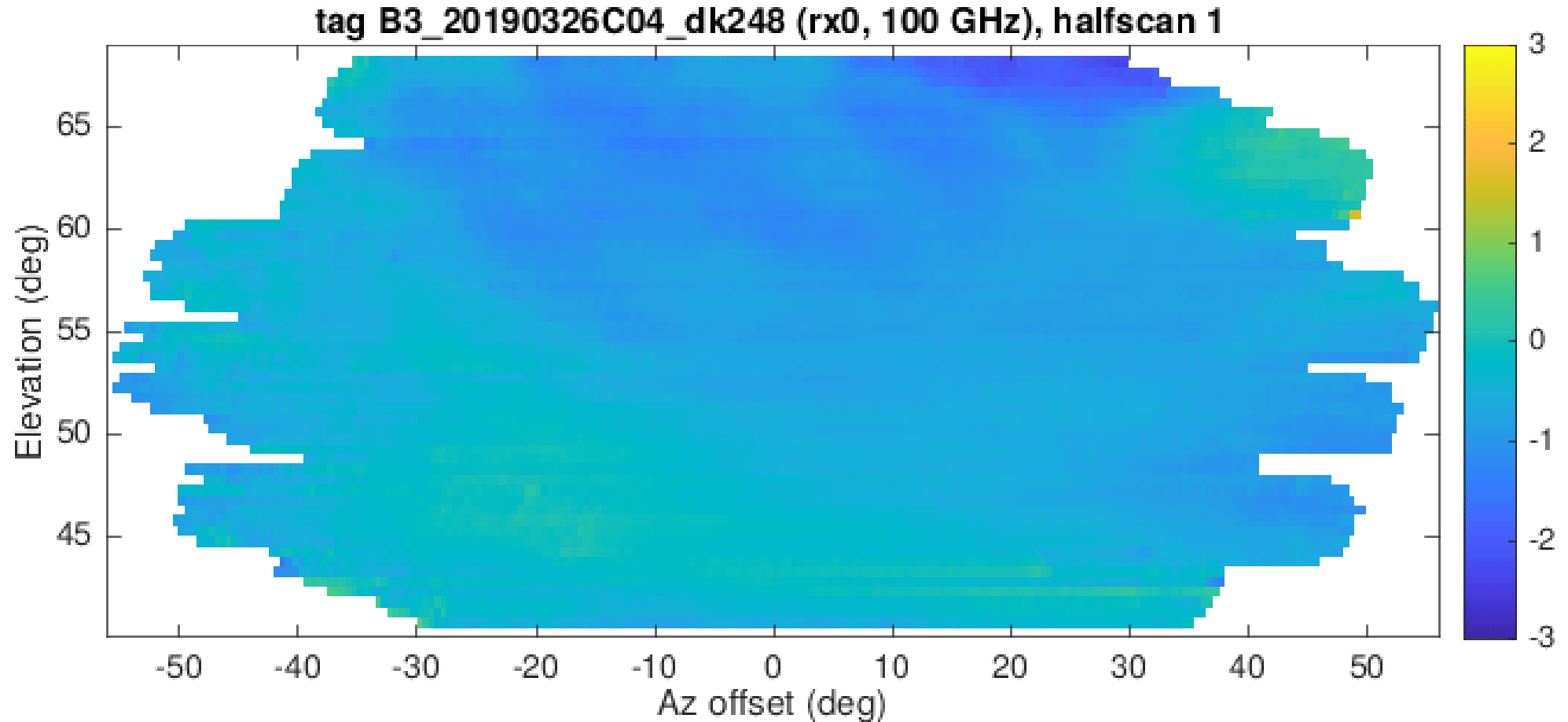
= Combined distance from Boston of **~13,250 miles**

The Atmosphere



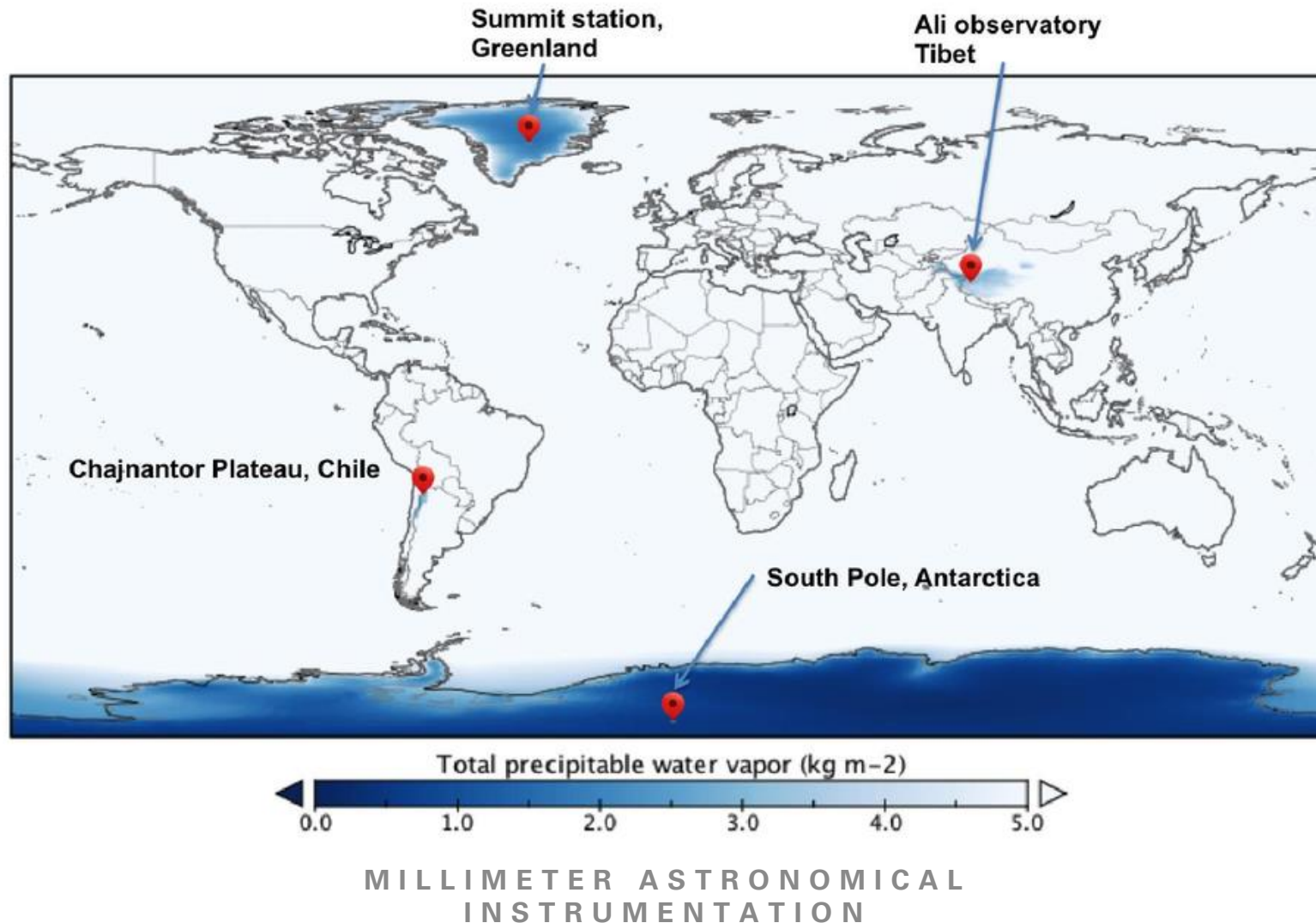
gif: Jae Hwan Kang

The Atmosphere



gif: Jae Hwan Kang

A High Dry Desert



Elevation:
~9,300 ft

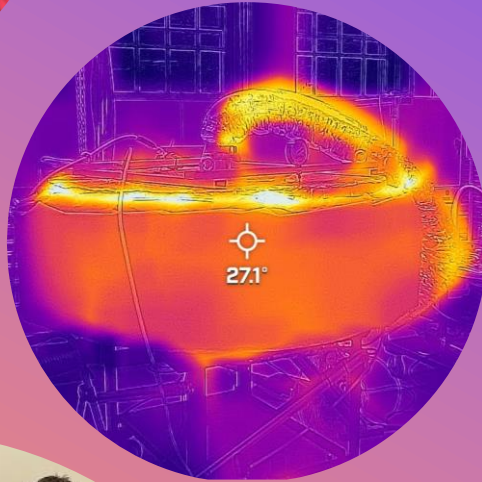
Approximately
3x higher than
Mount Greylock

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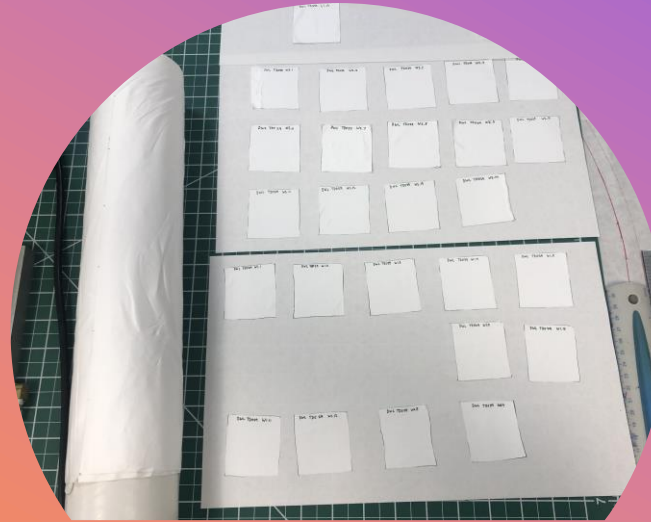
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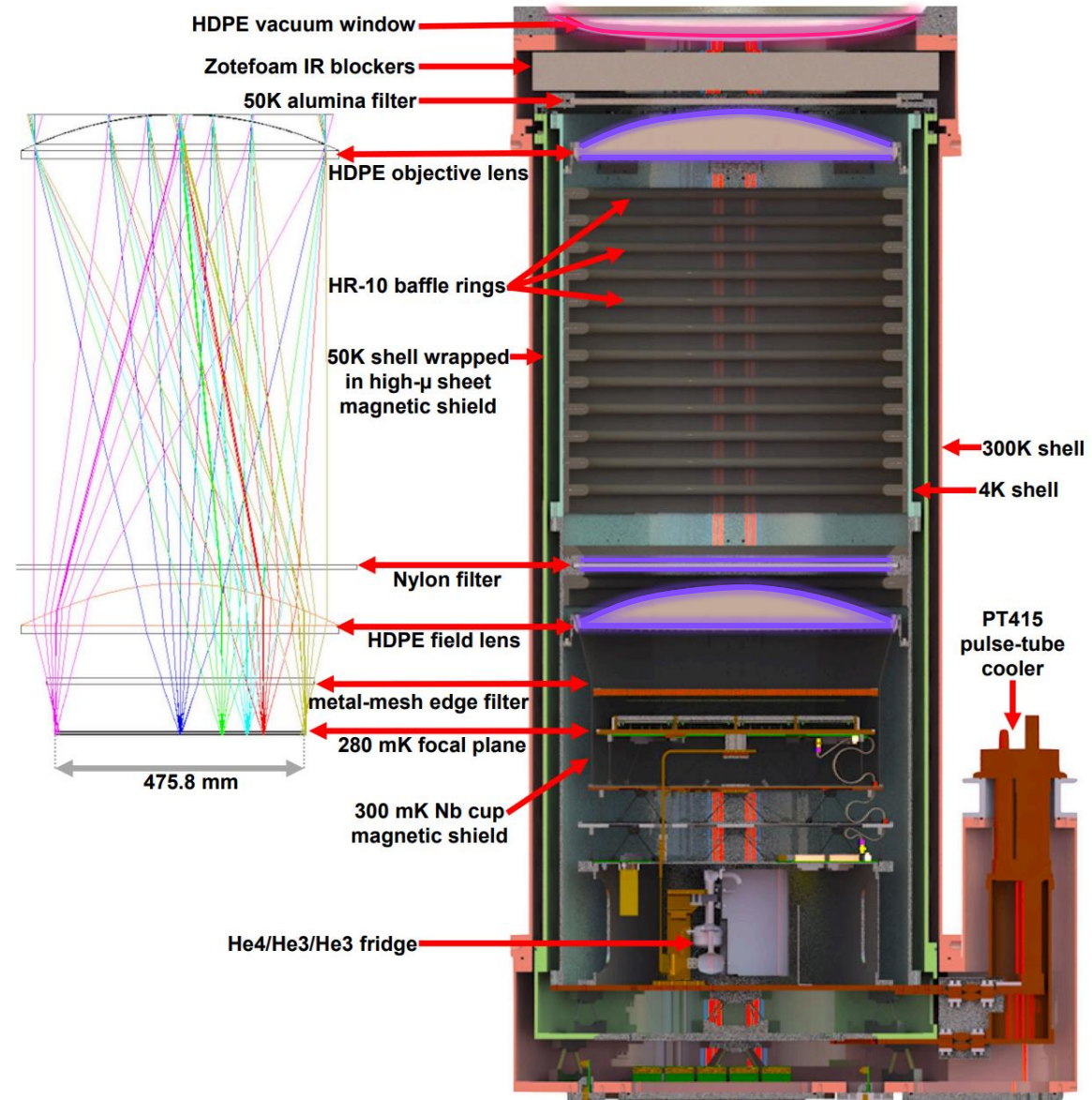


WHAT DO I ACTUALLY WORK ON?

Telescope's Optics

They have to get really cold!

- Our optics are cooled to 4 Kelvin
 - 0 Kelvin is absolute zero (-459.7 F)
 - 4 K is -452.5 F
- Our detectors are cooled to 0.25 K
 - About -459.2 F
- I work on the optics materials research and testing
 - Specifically on the vacuum window and the plastic anti-reflection coatings



Why do you have to make all
the optics so cold?

What's an anti-reflection coat?

POTENTIAL ADDITIONAL QUESTIONS

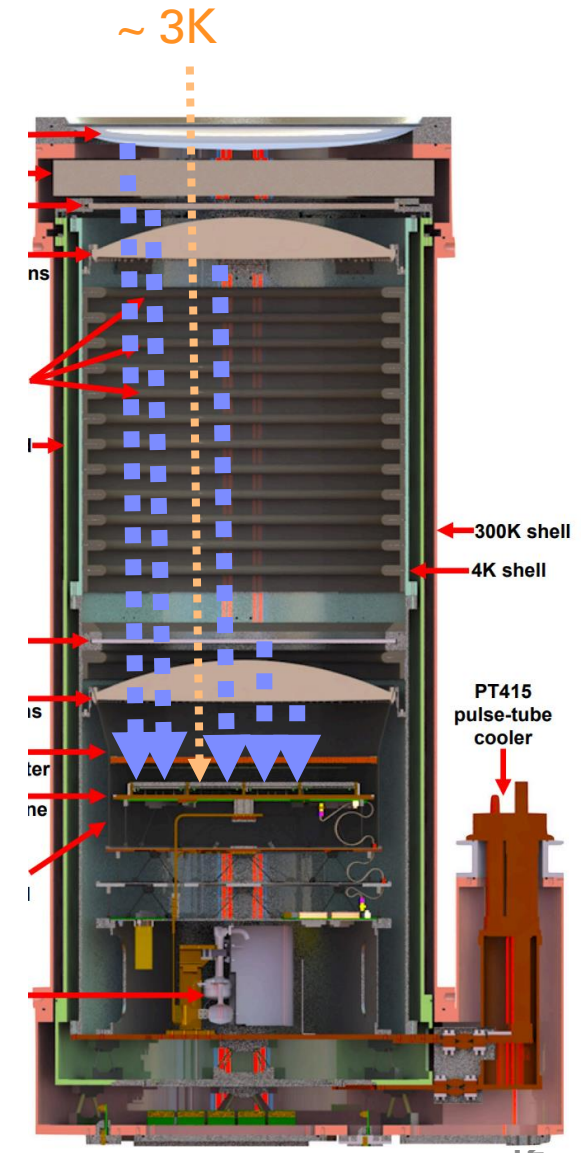
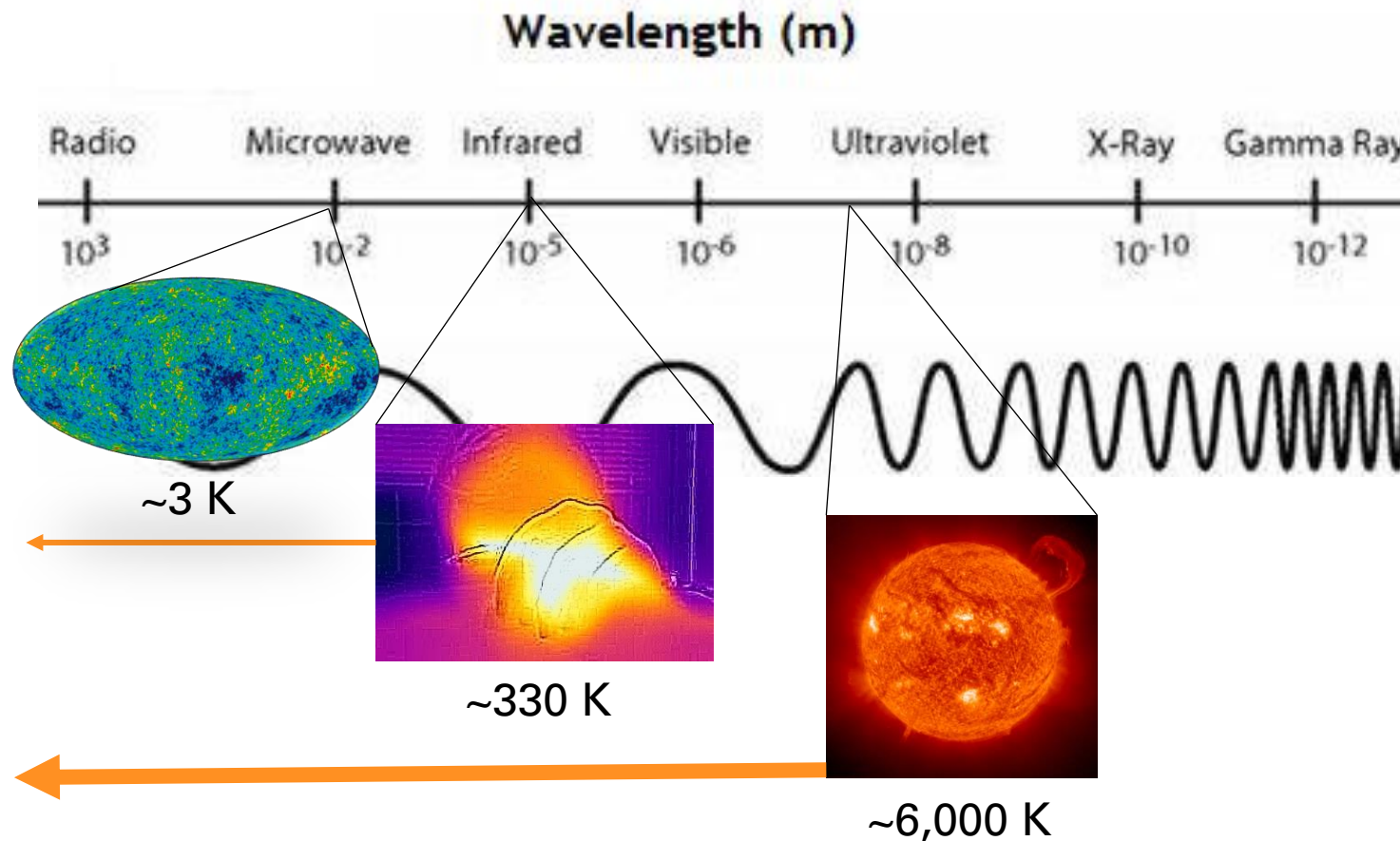
Plus additional explanations

What's a graduate student, anyway?

What's the CMB?

Why do you need a vacuum window?

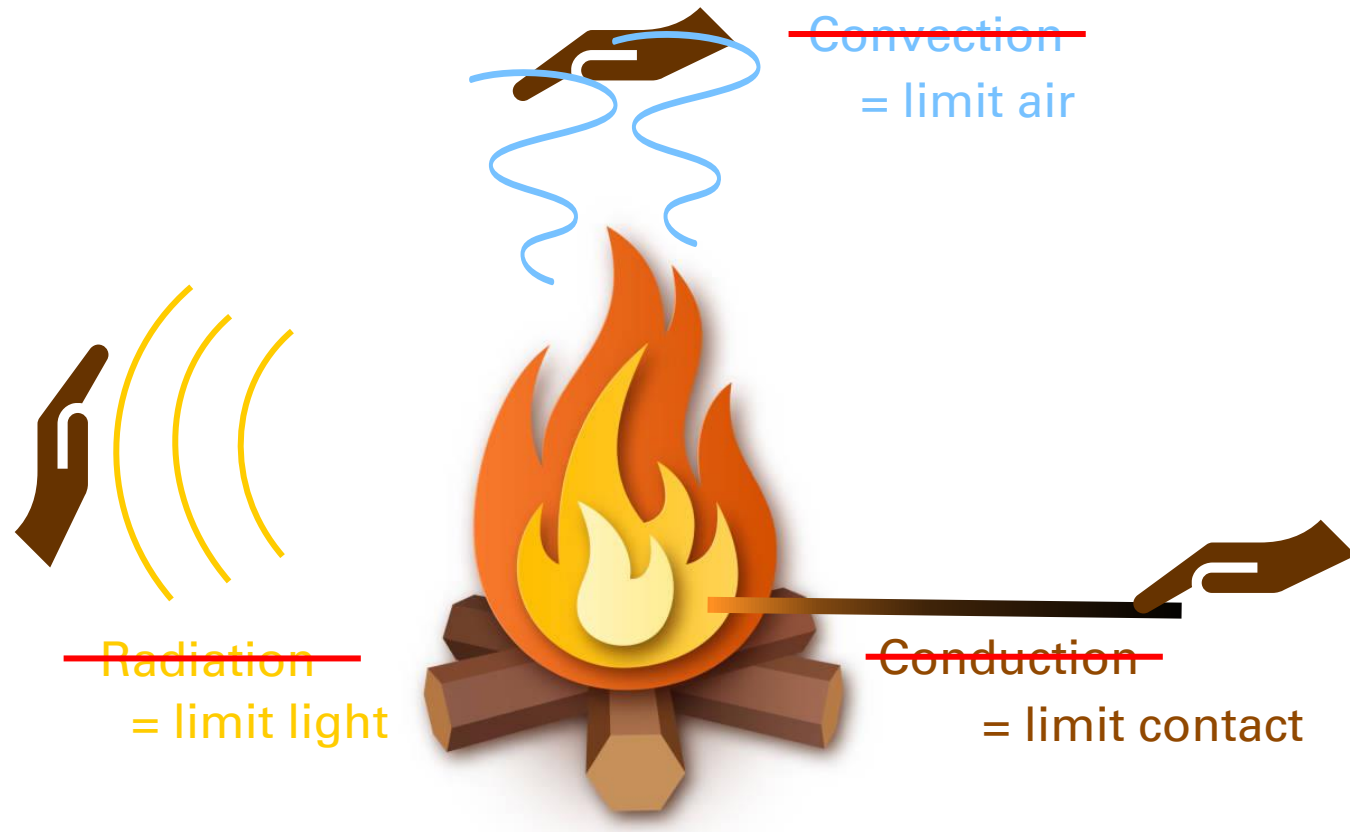
Why do you have to make all the optics so cold?



Why do you need a vacuum window?

What is **cold**? An absence of **heat**!

You make things **cold** by removing the **heat**,
and by preventing the **heat** from coming back



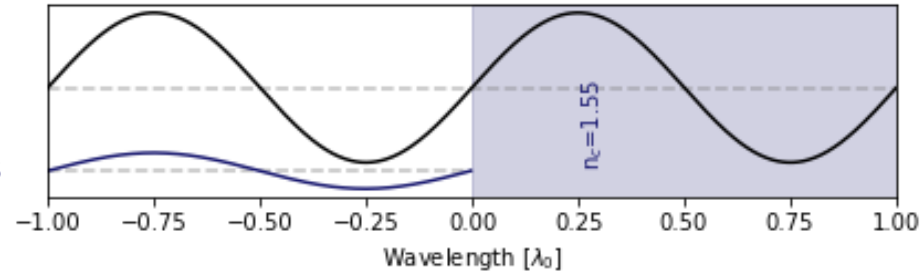
What's a graduate student, anyway?

1. Primary education
 - Elementary school/middle school (~8 years)
2. Secondary education
 - High school (~4 years)
 - High school diploma/GED
3. Tertiary education
 - College/university (~2 – 4 years)
 - Associates/Bachelors degrees
4. Quadary education (it's never called this!)
 - Graduate school (~2 – 6 years)
 - Masters/Doctorate

Higher
Education

What's an anti-reflection coat?

A wave (like light) encounters an impedance and reflects

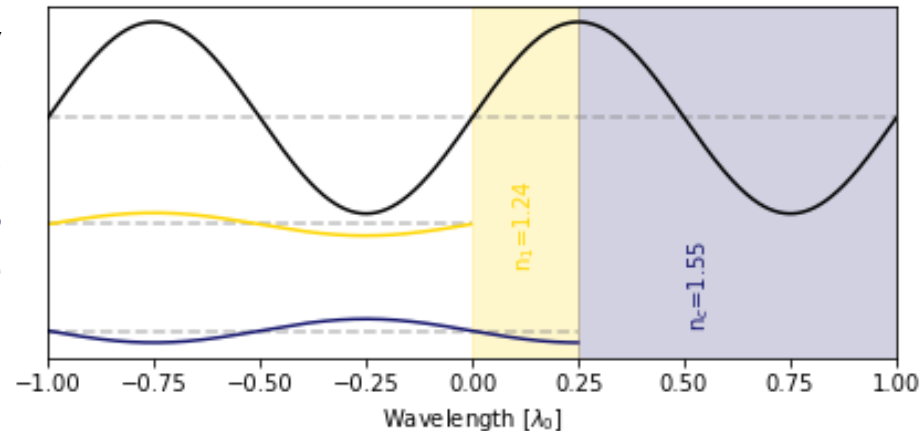


Results in:

- Lost light (in this case, ~20%)
- Light going where you don't want it

If you add an intermediary layer:

If the intermediary layer is $\frac{1}{4} \lambda$ thick and an even step up in impedance, then the reflected waves destructively interfere (cancel)



Results in:

- Less lost light
- Less light going where you don't want it

What's the CMB?

Cosmic Microwave Background

