Astronomy in Chemistry (and Physics)

John Percy

Department of Astronomy & Astrophysics
and
OISE Science, Math and Technology Ed
University of Toronto

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john.percy at utoronto.ca

Why?

“Universal” applications of chemistry

Cross-curricular connections

Integrated approach to science

Engage and inspire the students

Students love it!

Some Goals

- Understand/engage with “big ideas”
- Think critically about these and other topics
- Roles of observation and simulation
- Historical and cultural dimensions of astronomy
- Connect with sky and universe!
- Connect with (and understand) awesome images
- Communicate via print and electronic means

Inspiration!

Something has blown this star to smithereens, and created the atoms of which you are made.

[It was recorded by Chinese astronomers in 1054 during the European “Dark Ages”]

What chemistry and physics is shown in this image?

Grade Nine Astronomy

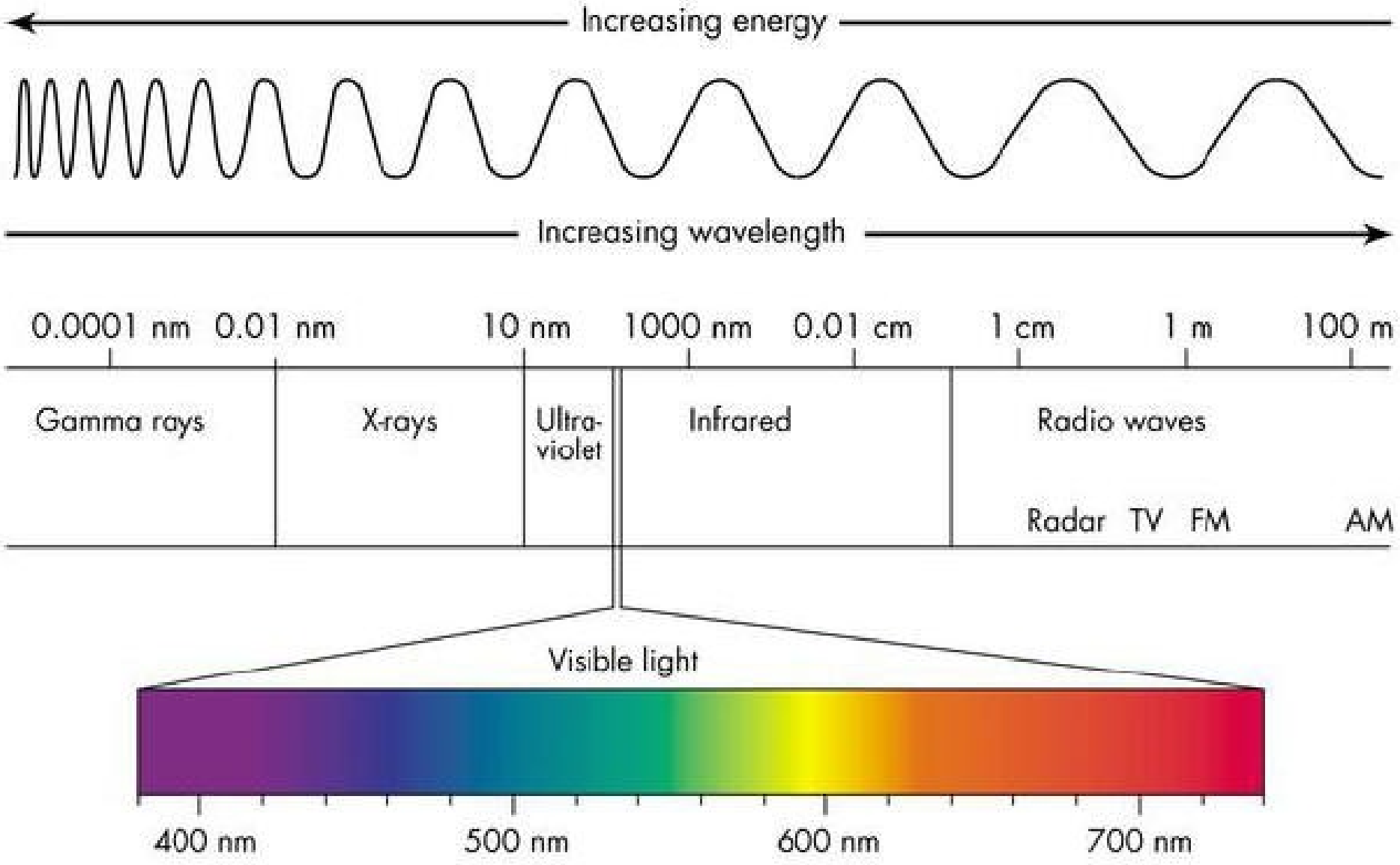
https://stao.ca/resources/Gr9AstroHandout.pdf

http://www.astro.utoronto.ca/~percy/EPOindex.htm

http://www.astro.utoronto.ca/~percy/grade9workshop.htm

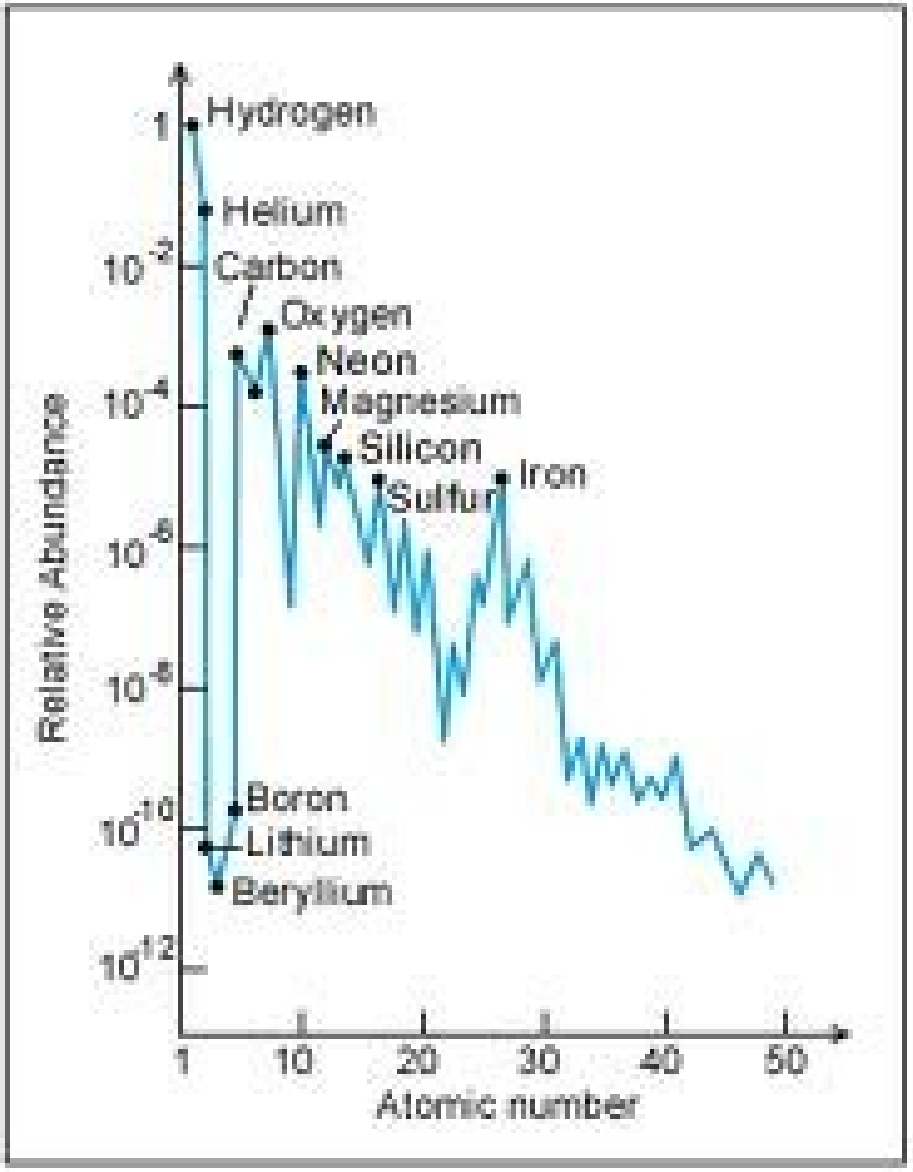
Astrochemistry: The study of the abundances and reactions of chemical elements and molecules in the universe, and their interaction with radiation.

Electromagnetic Radiation


Increasing energy
Increasing wavelength
0.0001 nm
0.01 nm
10 nm
1000 nm
0.01 cm
1 cm
1 m
100 m
Gamma rays
X-rays
Ultra-violet
Infrared
Radio waves
Radar
TV
FM
AM
Visible light
400 nm
500 nm
600 nm
700 nm

Nuclei

What is the Universe Made Of?

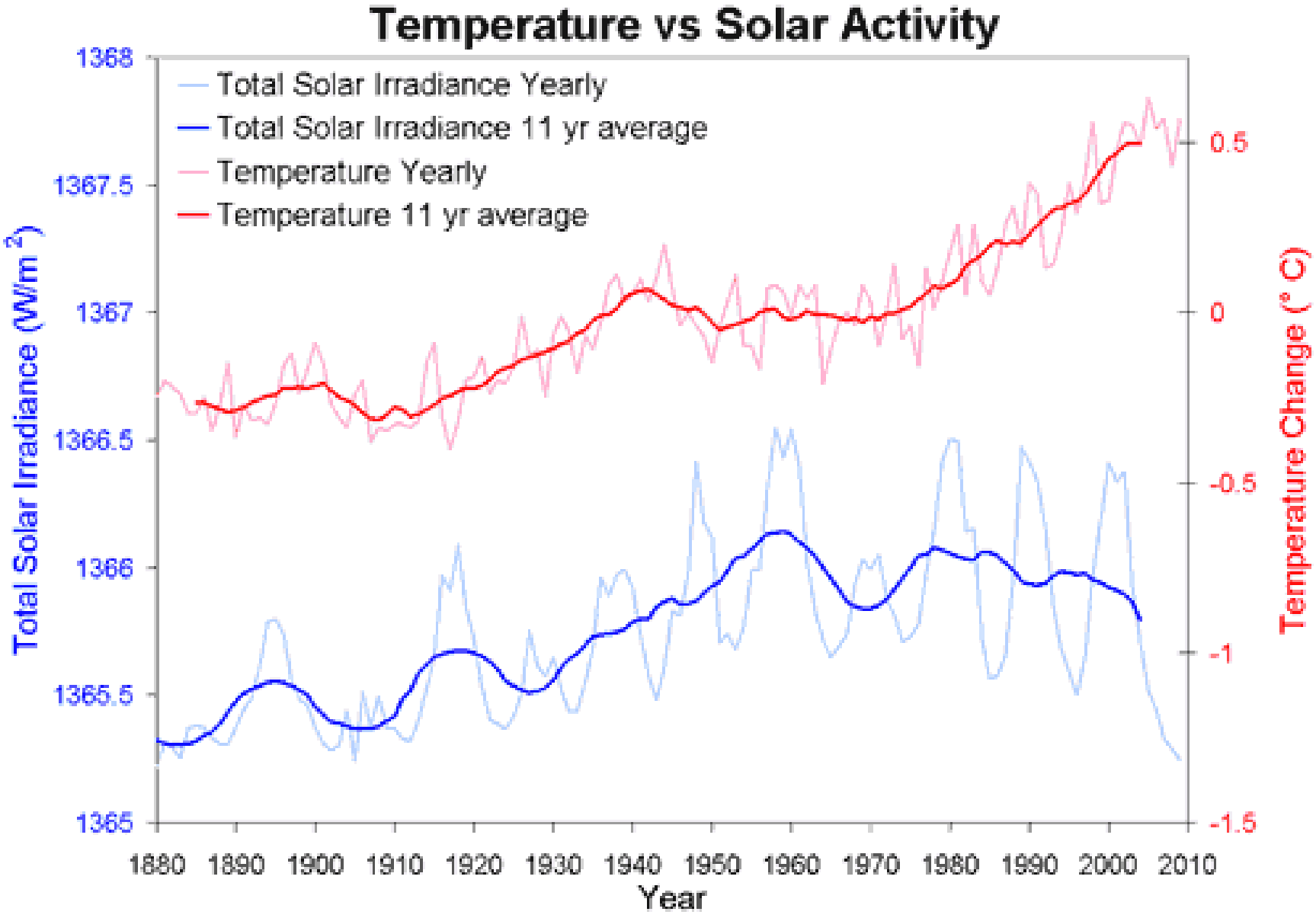


- Describe this graph in words
- How did these abundances come about?

Thermonuclear Fusion

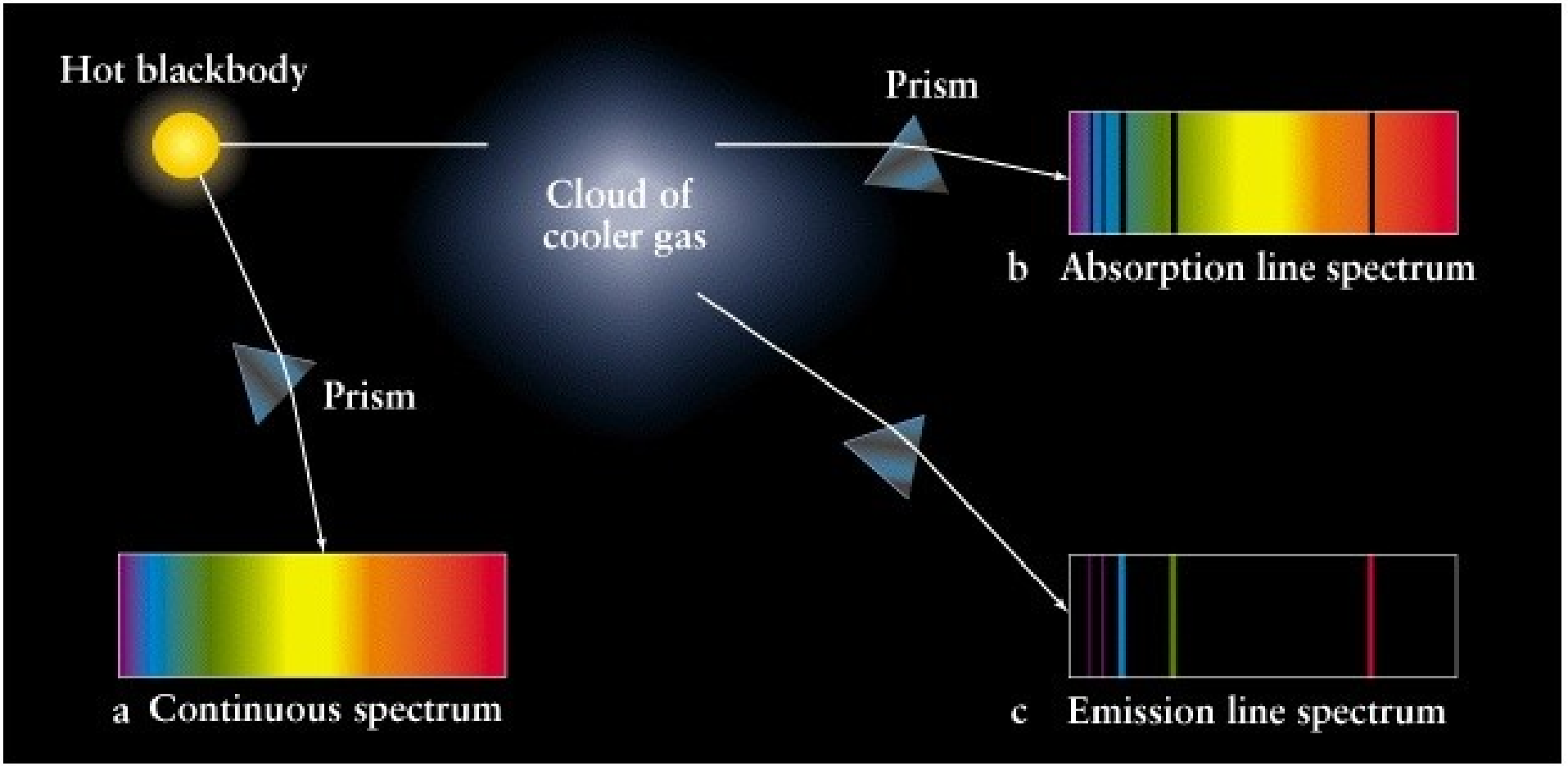
- The sun shines with a power of 400 million million million million Watts, and has done so for 4.5 billion years
- How does this process work?

Can the Sun Explain Climate Change?

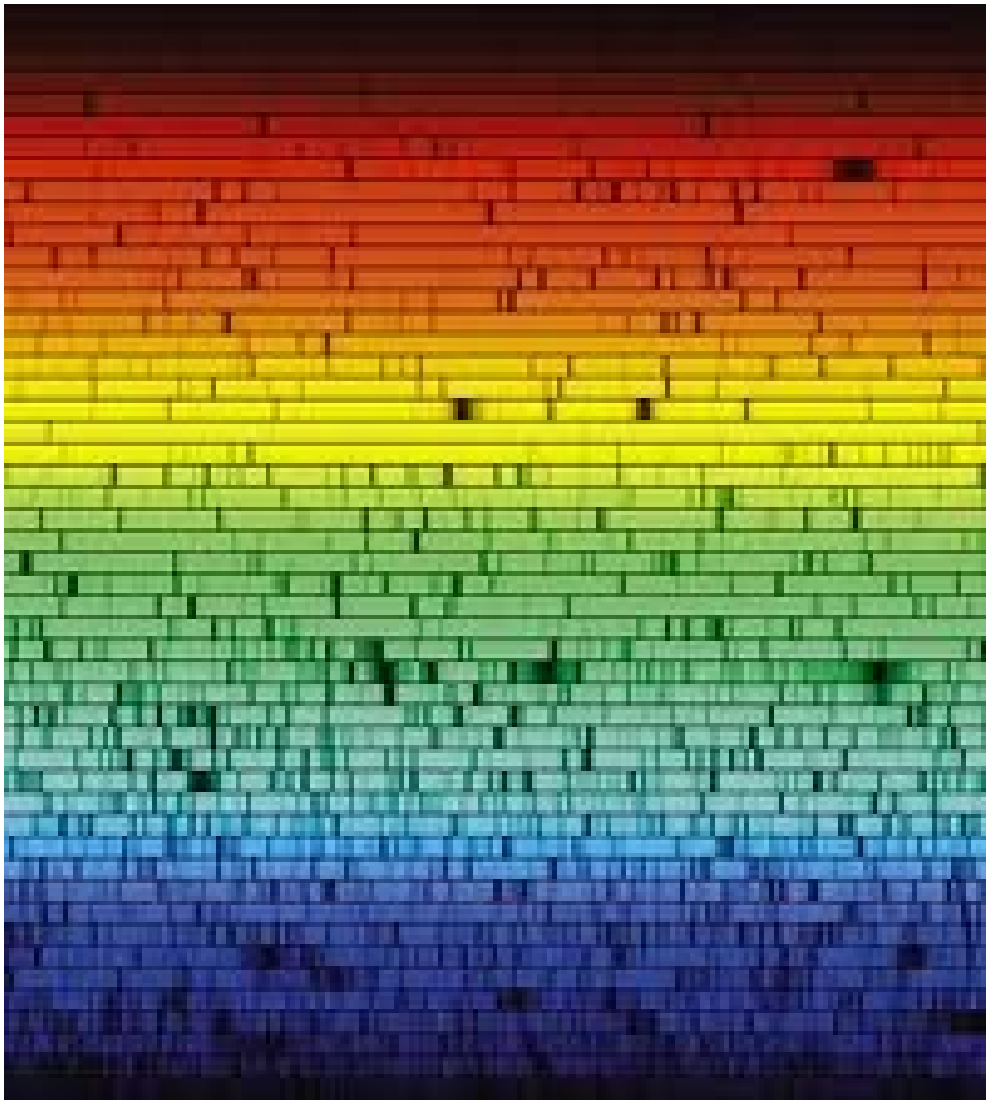


Atoms

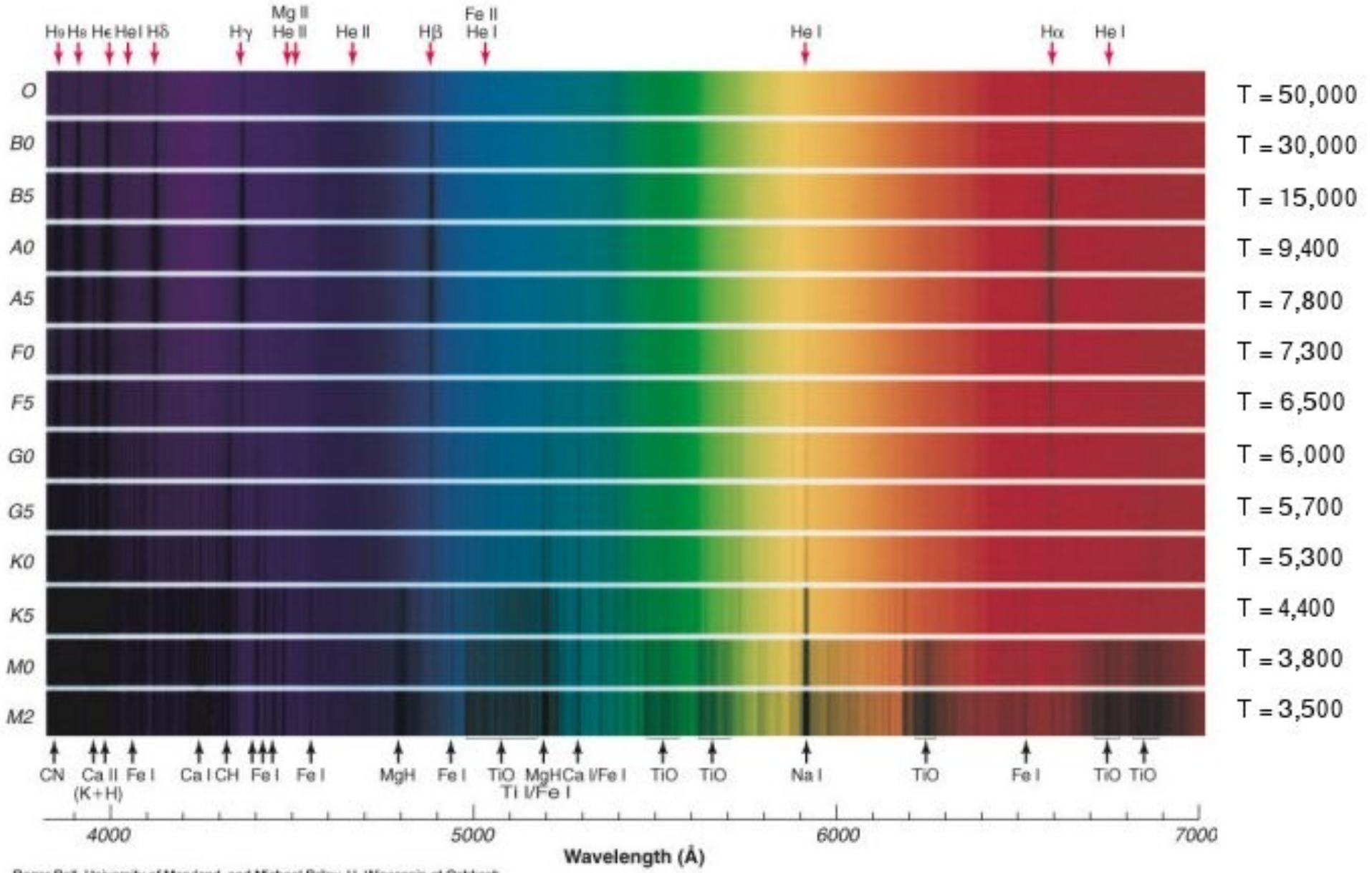
Spectra


Hot blackbody
Prism
Cloud of cooler gas
b Absorption line spectrum
Prism
a Continuous spectrum
c Emission line spectrum

How Do We Know Cosmic Abundances?



Taking Stars' Temperatures

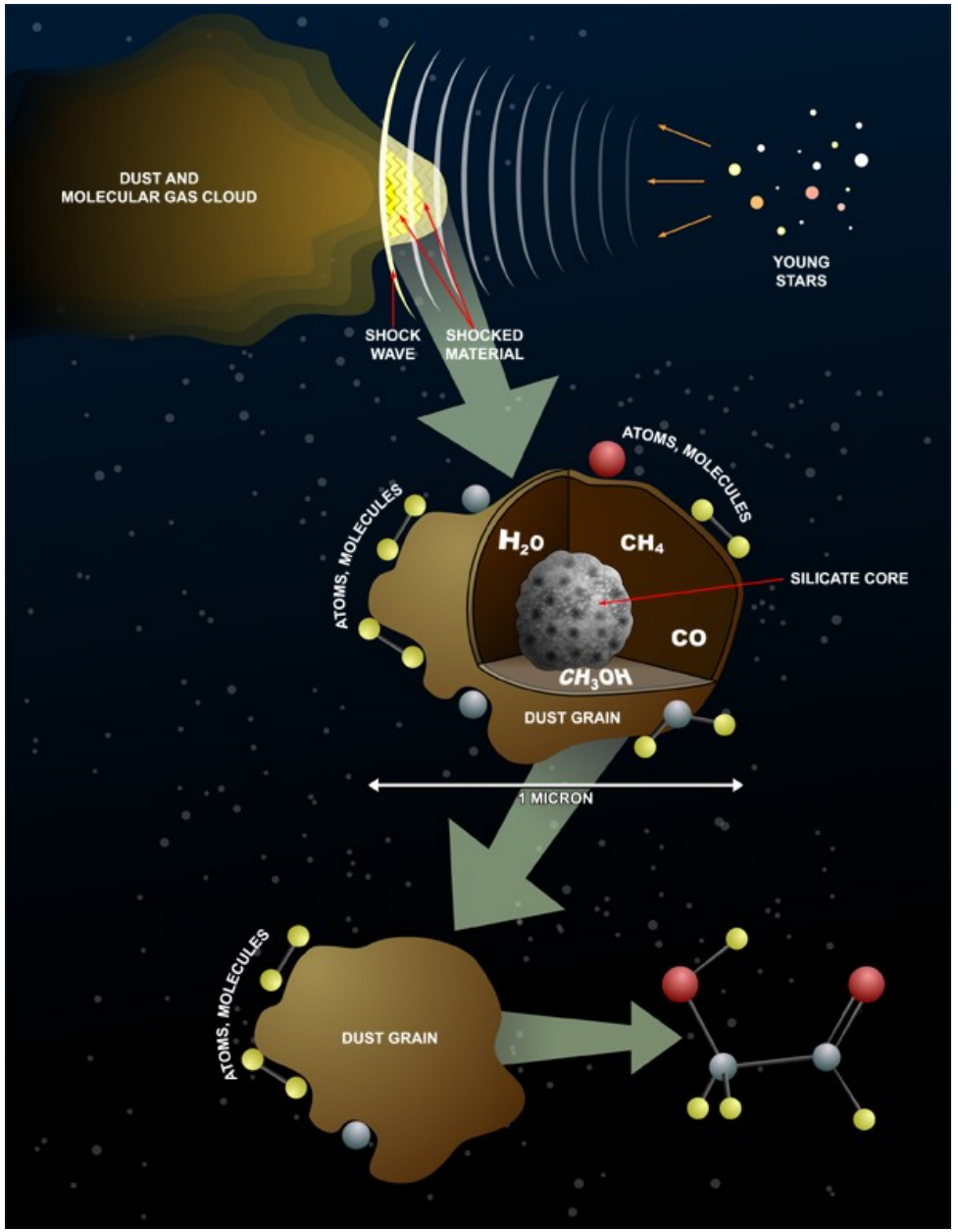


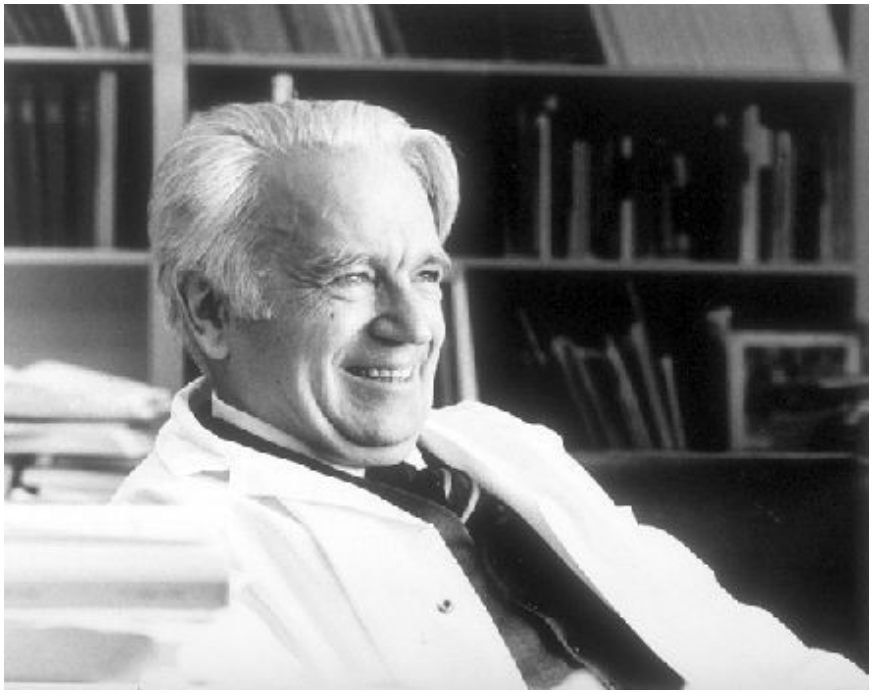
Roger Bell, University of Maryland, and Michael Briley, U. Wisconsin at Oshkosh

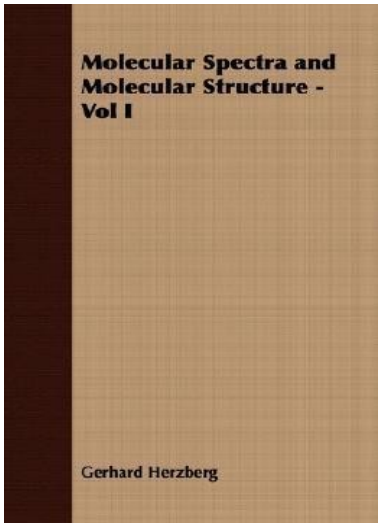
Kinetic Theory
Why Don't Stars Collapse?

Molecules

Interstellar Molecules





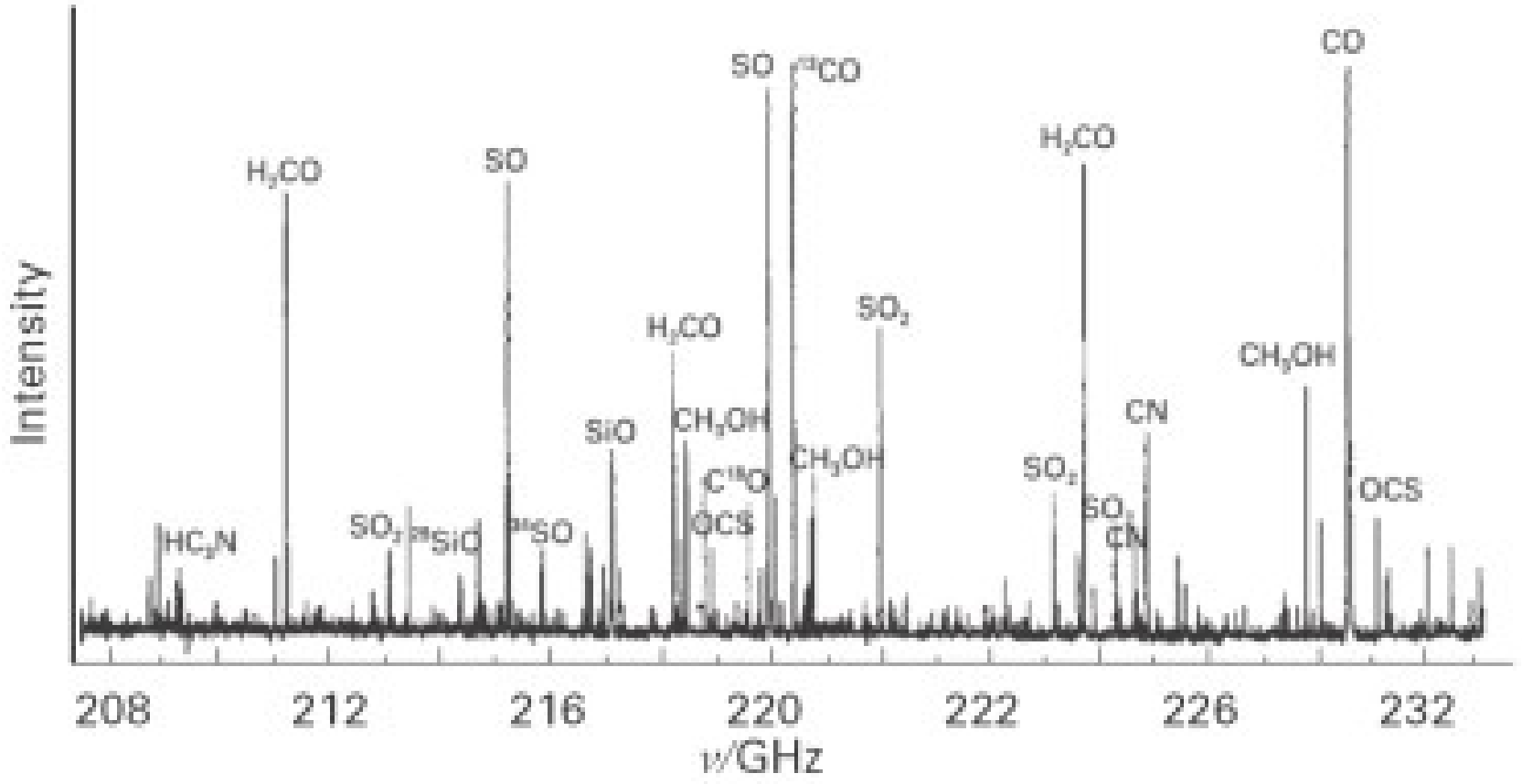


Canadian Nobel Laureate Gerhard Herzberg

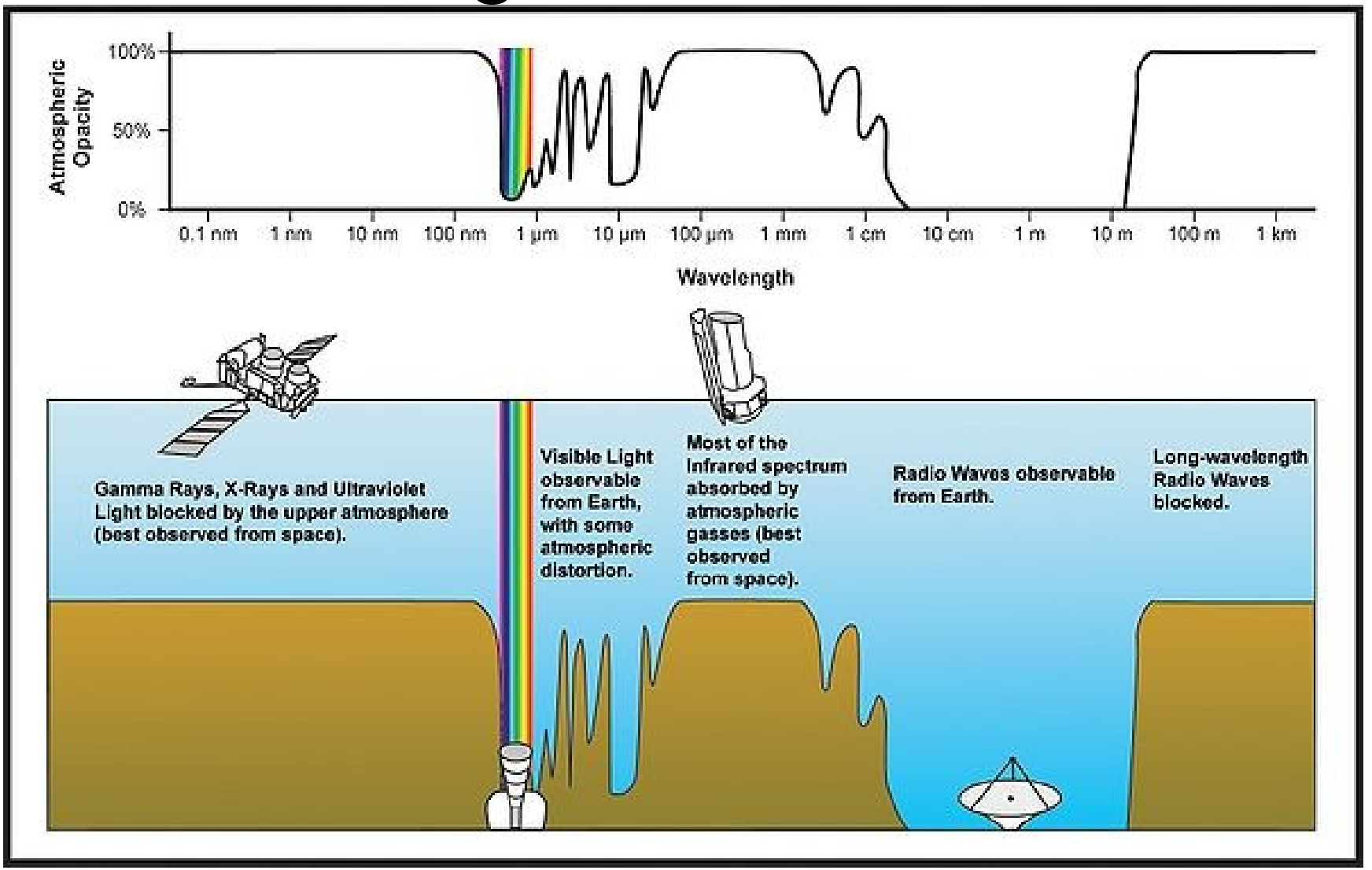
And one of his books

Interstellar Molecules

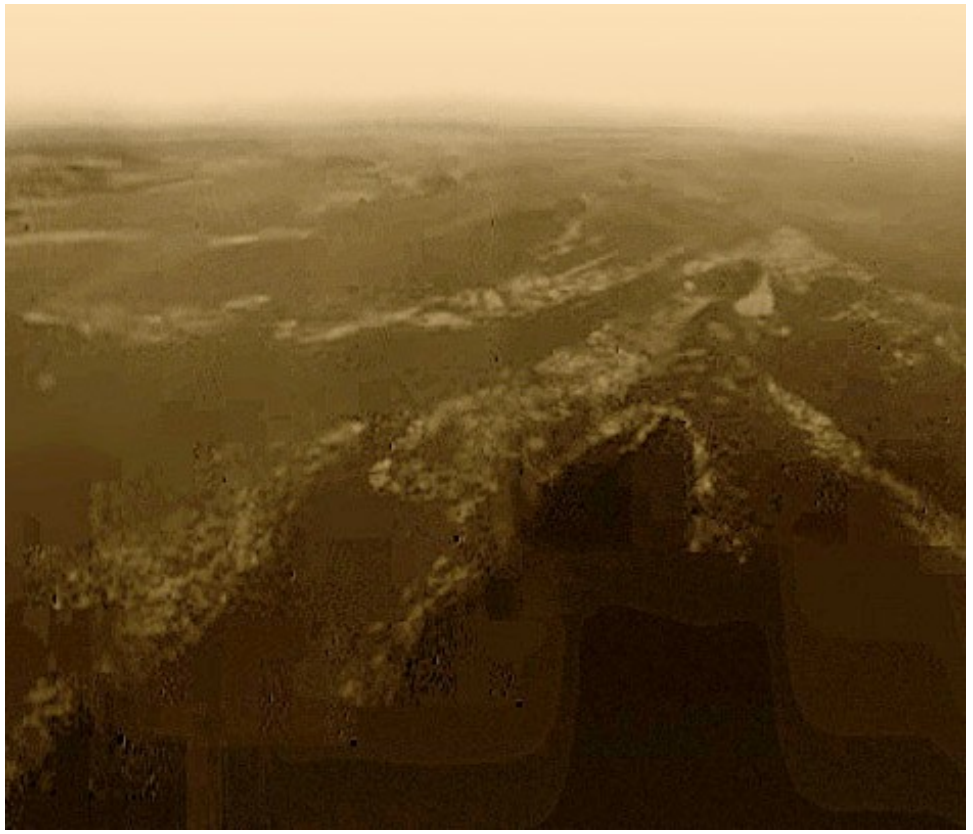
The search for pre-biological molecules

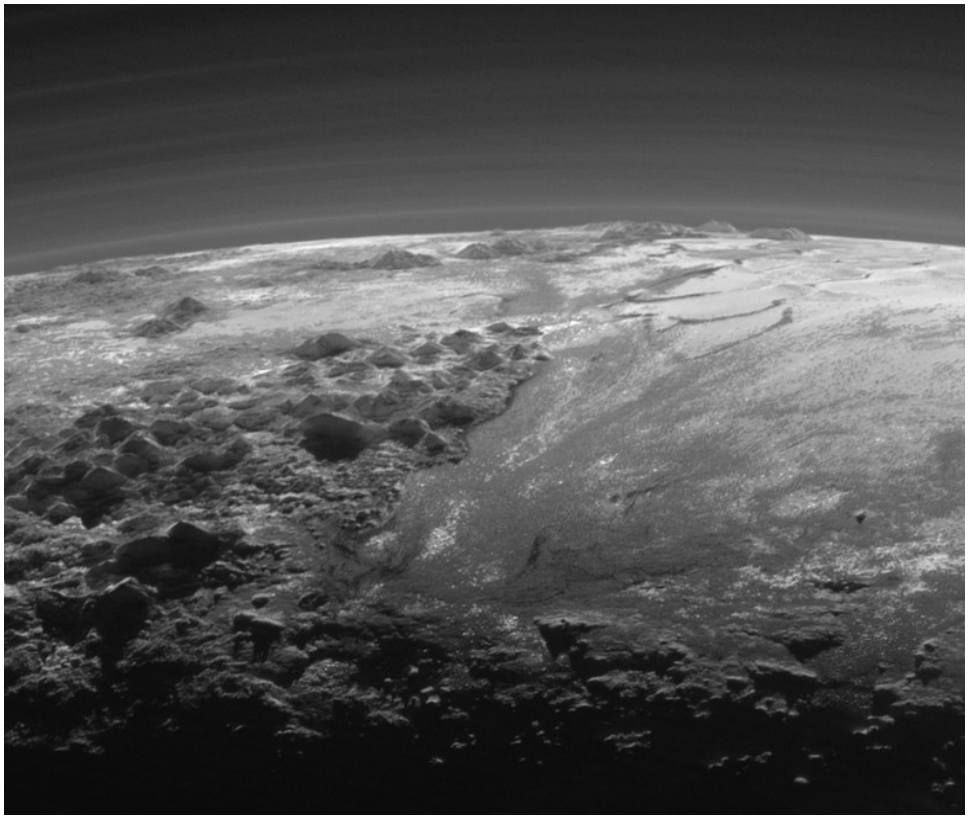


Atmospheric “Windows” and the greenhouse effect



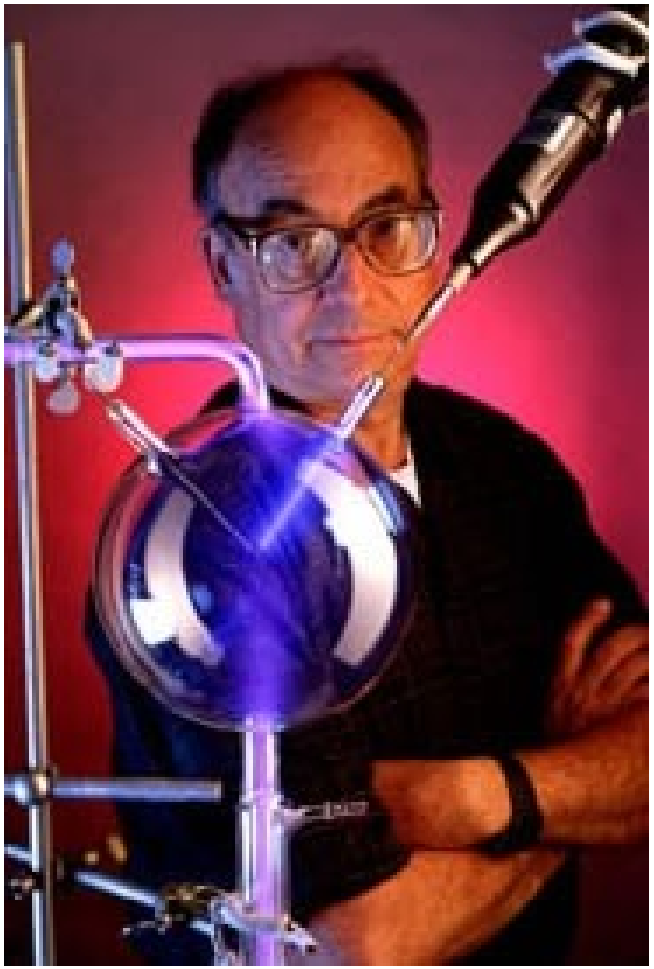
States of Matter at Different Temperatures



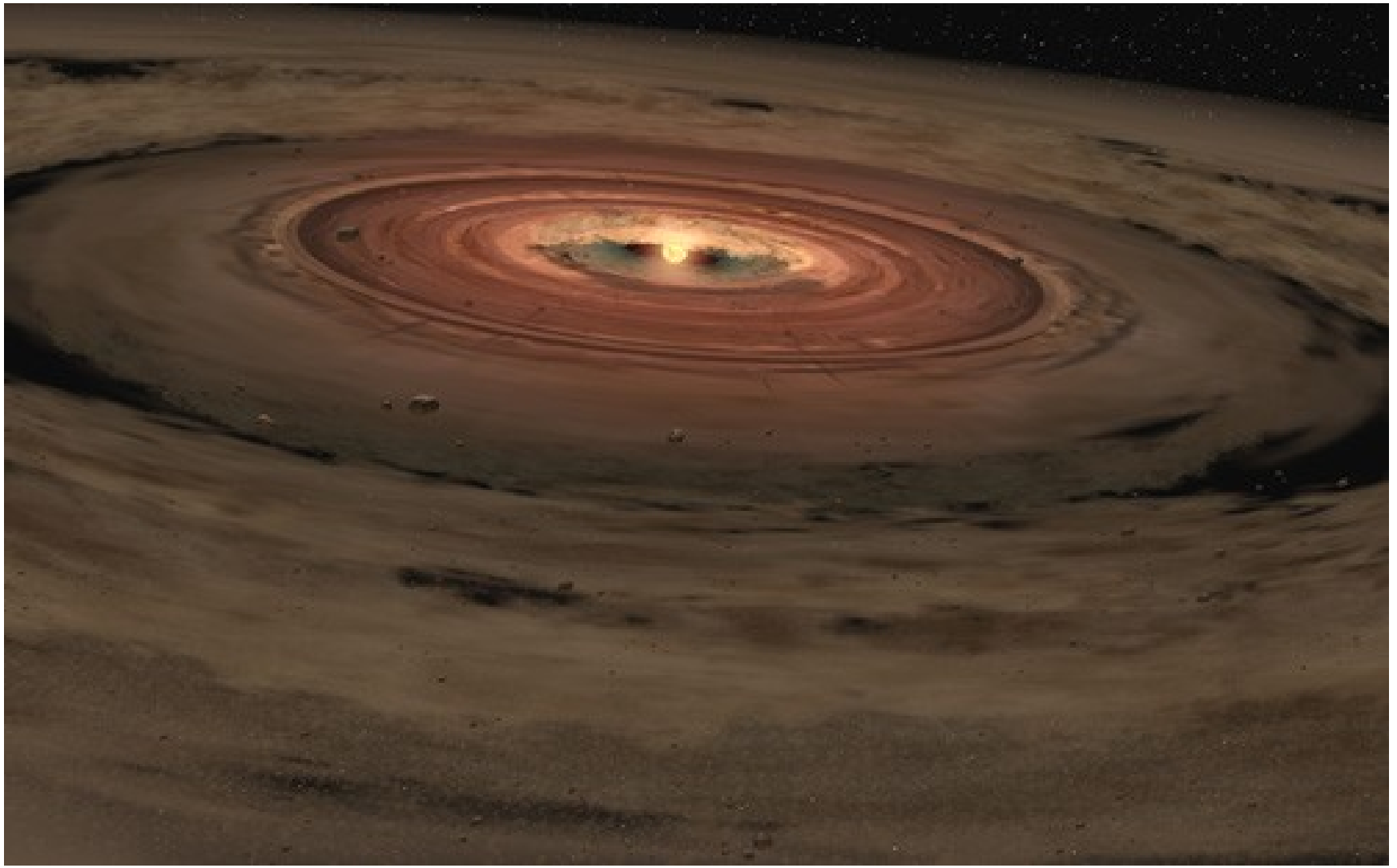


How Did Life Begin?

Miller (left)-Urey Experiment: simple molecules, plus energy, produce complex prebiological molecules. The same molecules are found in carbonaceous chondrite meteorites (right). Complex molecules form easily and naturally.



The Birth of the Solar System and of the molecules of life.



Career Considerations

- Astronomy education prepares for a wide variety of careers
- Women and some minorities are still under-represented in astronomy and other STEM areas
- Astronomy – including research, outreach, and communication -- can be done as a hobby

Resources