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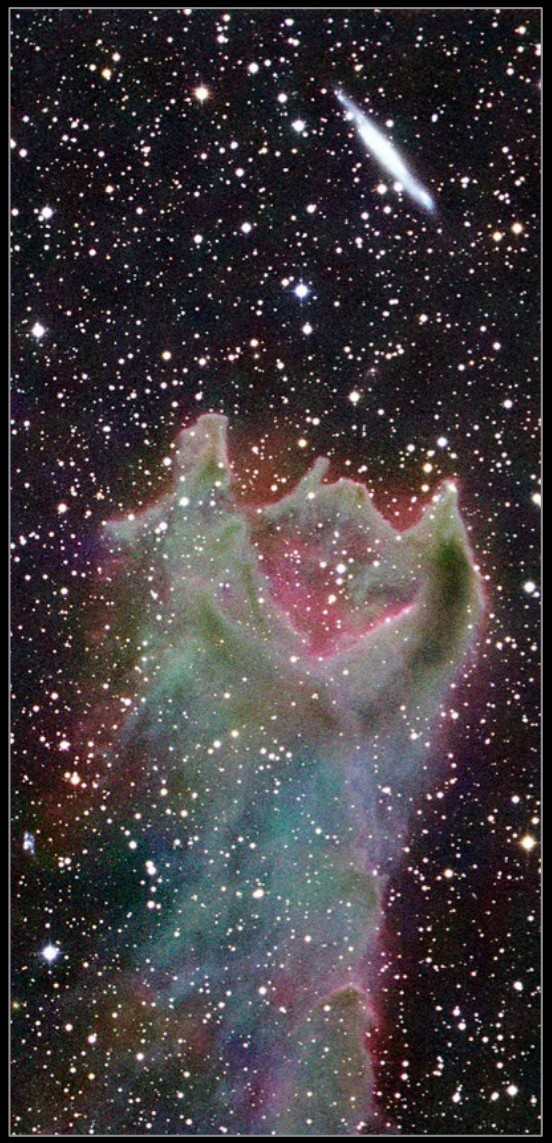


The Sounds of Space

Prof Bryan Gaensler

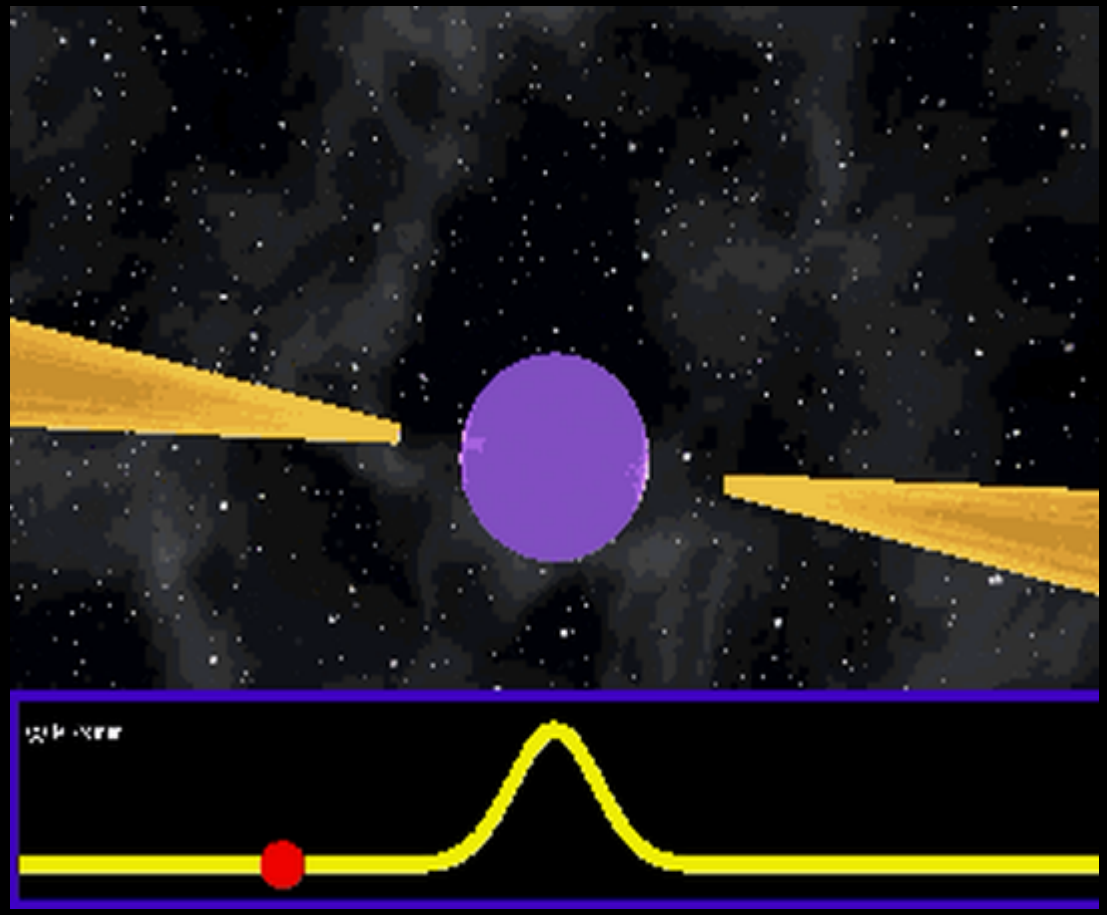
Director

Centre for All-sky Astrophysics

www.caastro.org

@SciBry

Pulsars



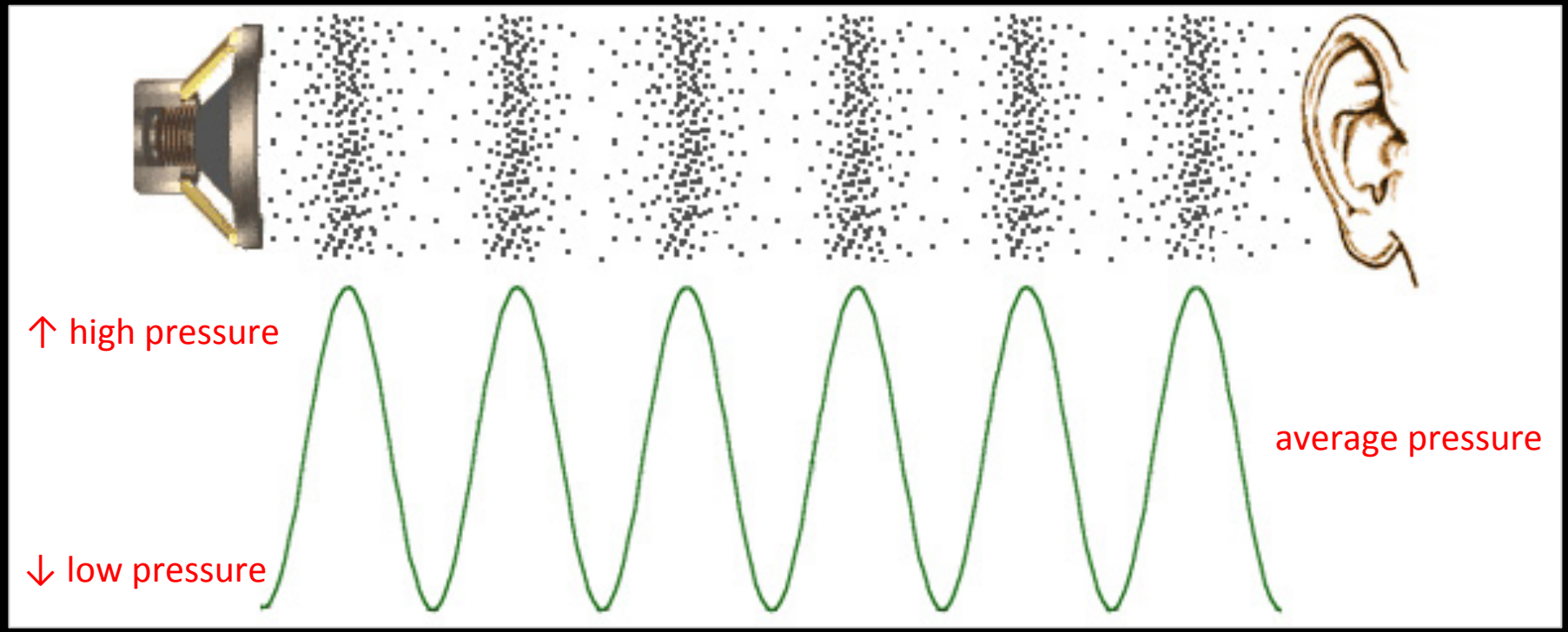



Is There Sound in Space?

Is There Sound in Space?

Is There Sound in Space?

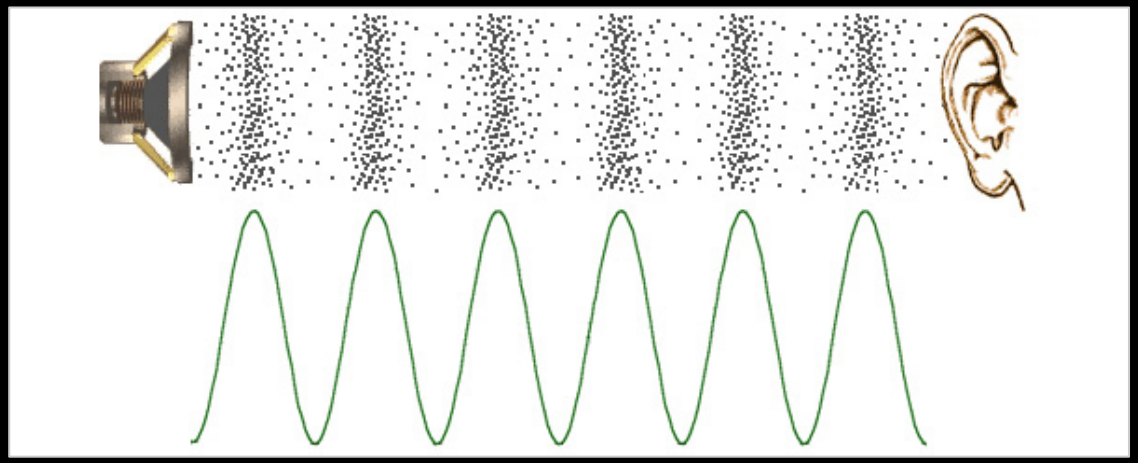
Sound Waves



Interstellar Gas

Nigel Sharp / NOAO / NSF; © AURA

Sound Waves:
Pressure Fluctuations Transmit Information



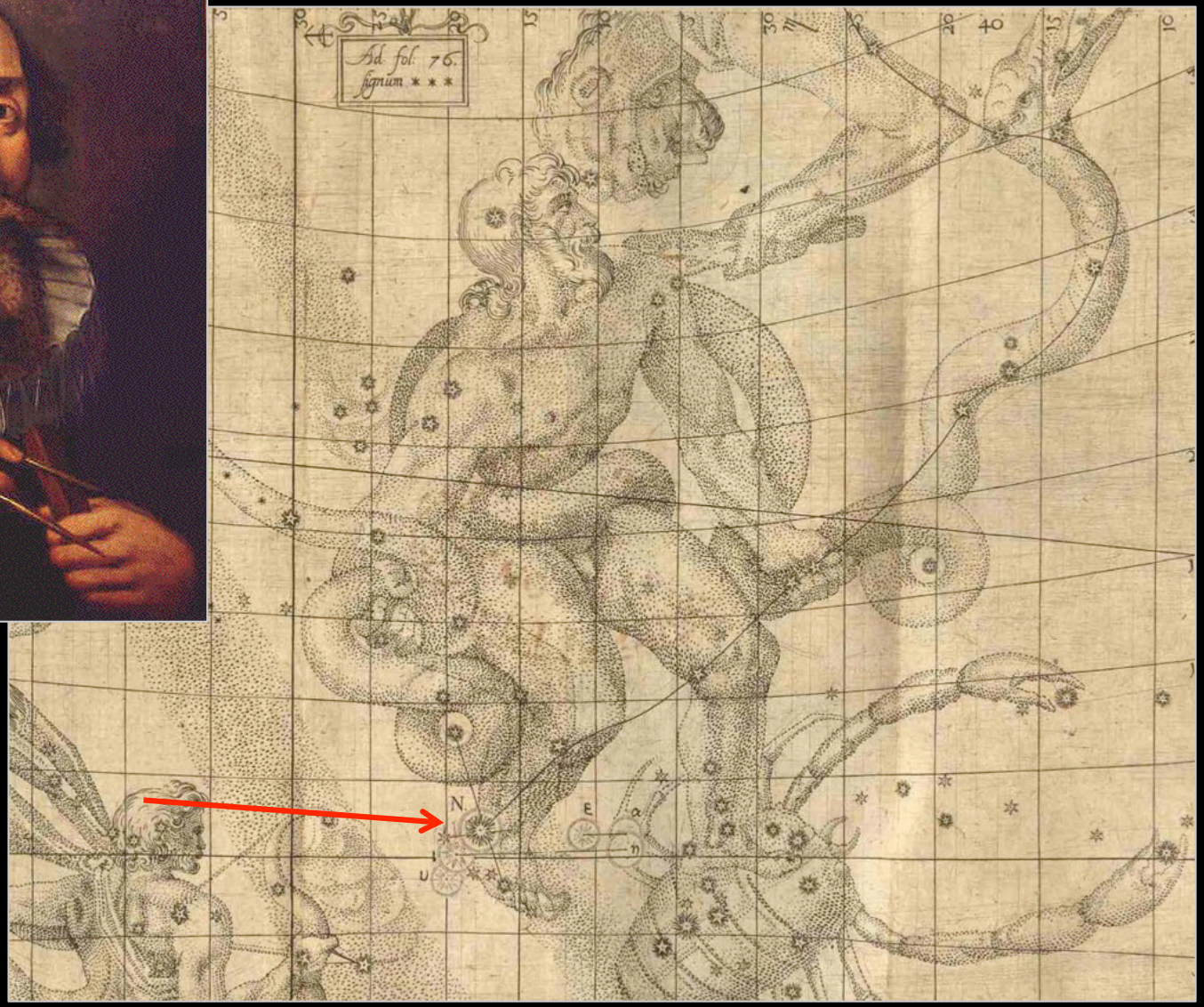
Speed of sound

- air at sea level: 330 metres per sec (1200 kph)
- “warm” interstellar gas: 10 km/s (36,000 kph)
- “hot” interstellar gas: 100 km/s (360,000 kph)

elementy.ru; Yosemite / wikipedia / bharatech.com

Sonic Boom

Johannes Kepler: “De Stella Nova”



NASA / Sternwarte Kremsmünster; New York Society Library

The Loudest Note: Kepler's Star

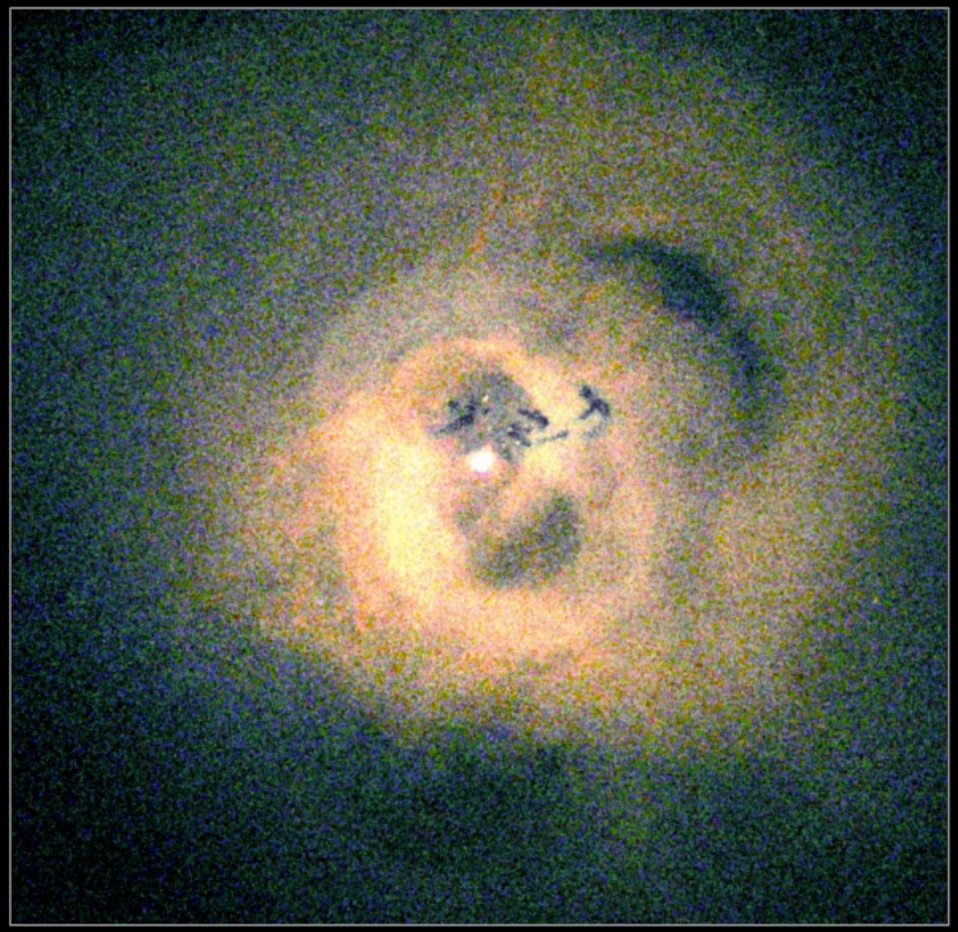
X-ray: NASA/CXC/NCSU/S Reynolds et al.; Optical: UKST/STFC/ AAO/DSS/STScI/AURA/NASA

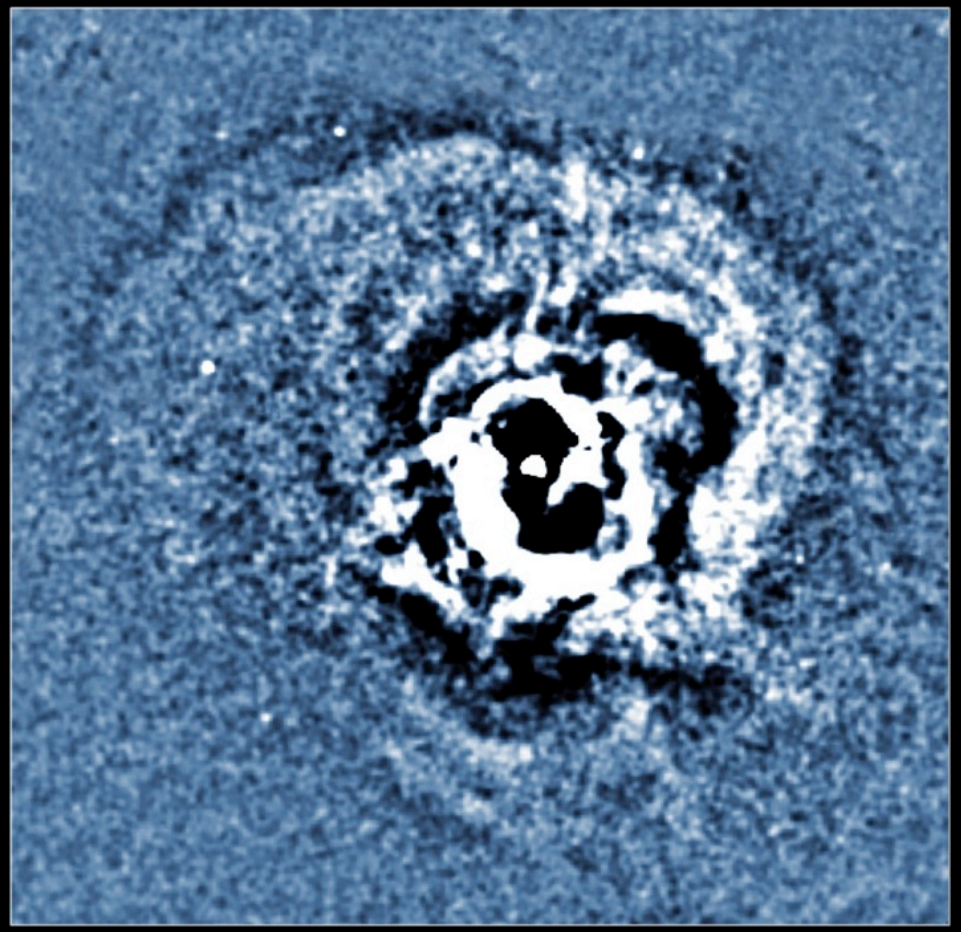
Sound of a Supernova?

- Sound measured in “decibels” (dB)
  - 30 decibels: a whisper
  - 60 decibels: conversation
  - 95 decibels: jackhammer
  - 115 decibels: rock concert

- Logarithmic pressure scale: pressure x10 means dB + 20
  - 0 dB = pressure fluctuation of 0.000000002%
    … so 60 dB = 0.000002%
  - Supernova: pressure fluctuation of 10^7
    … so volume is 330 dB!

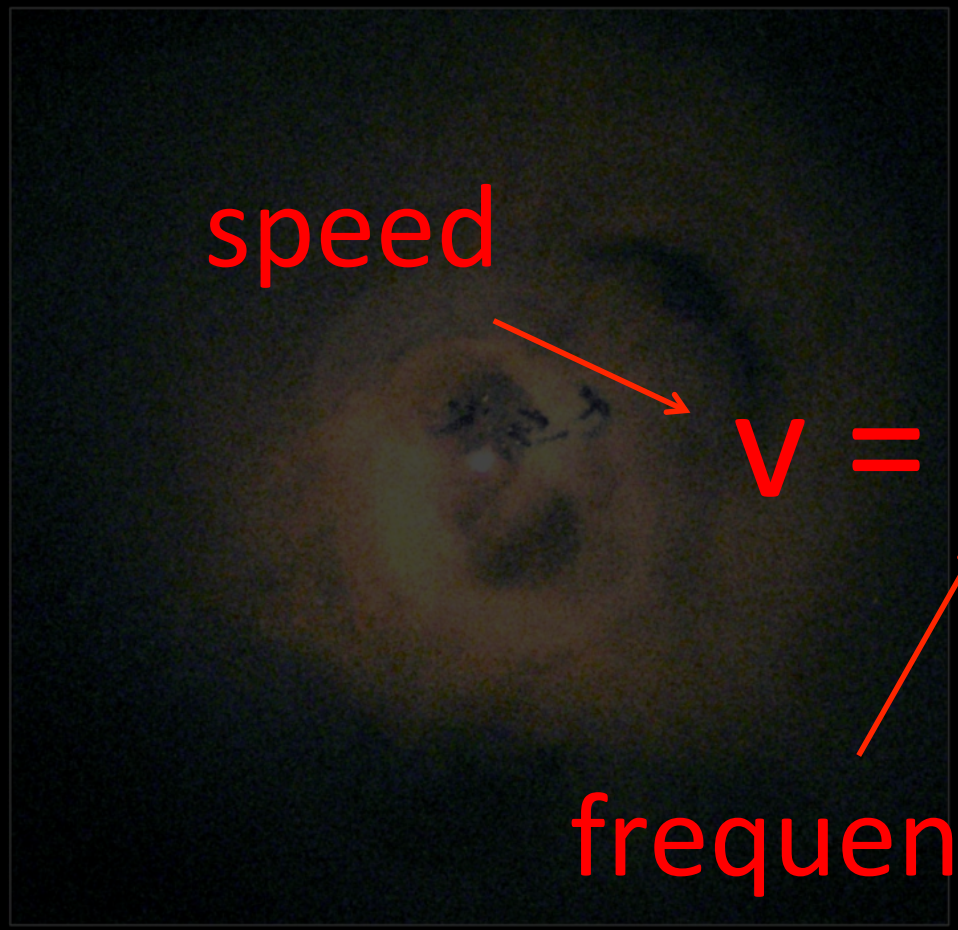
The Deepest Note: A Supermassive Black Hole

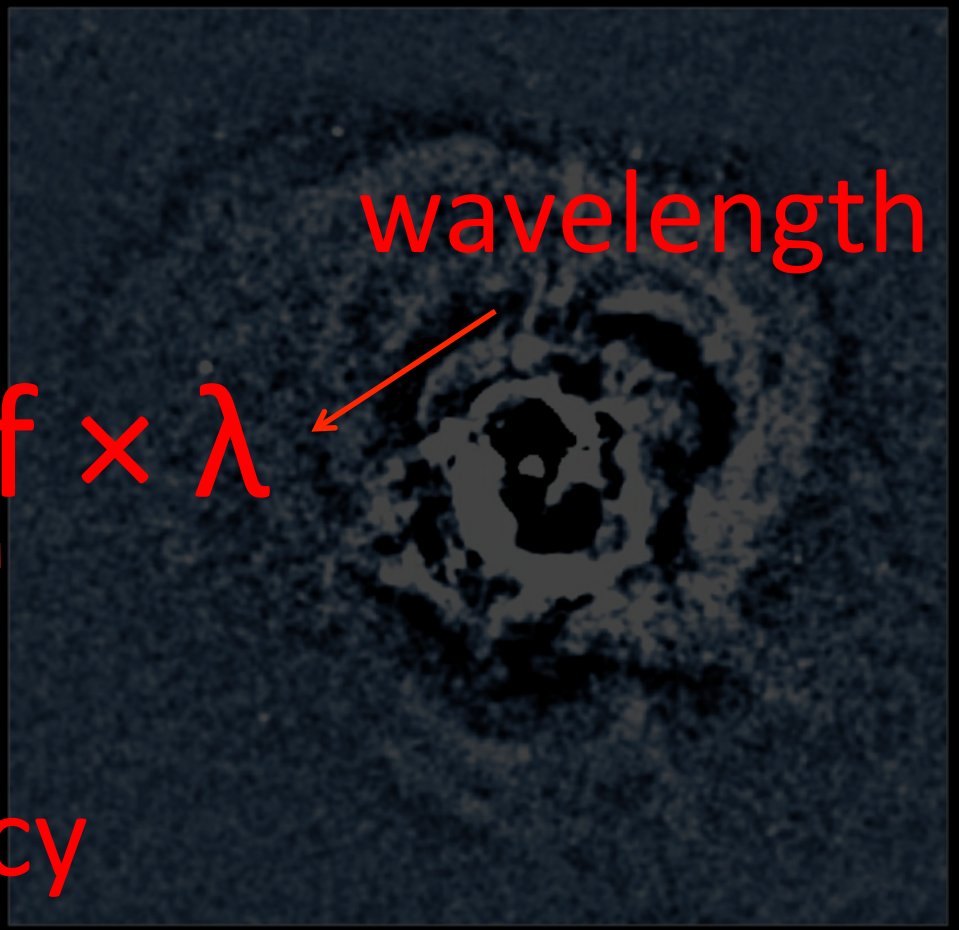




NASA/CXC/IoA/A Fabian et al.

The Deepest Note: A Supermassive Black Hole





speed

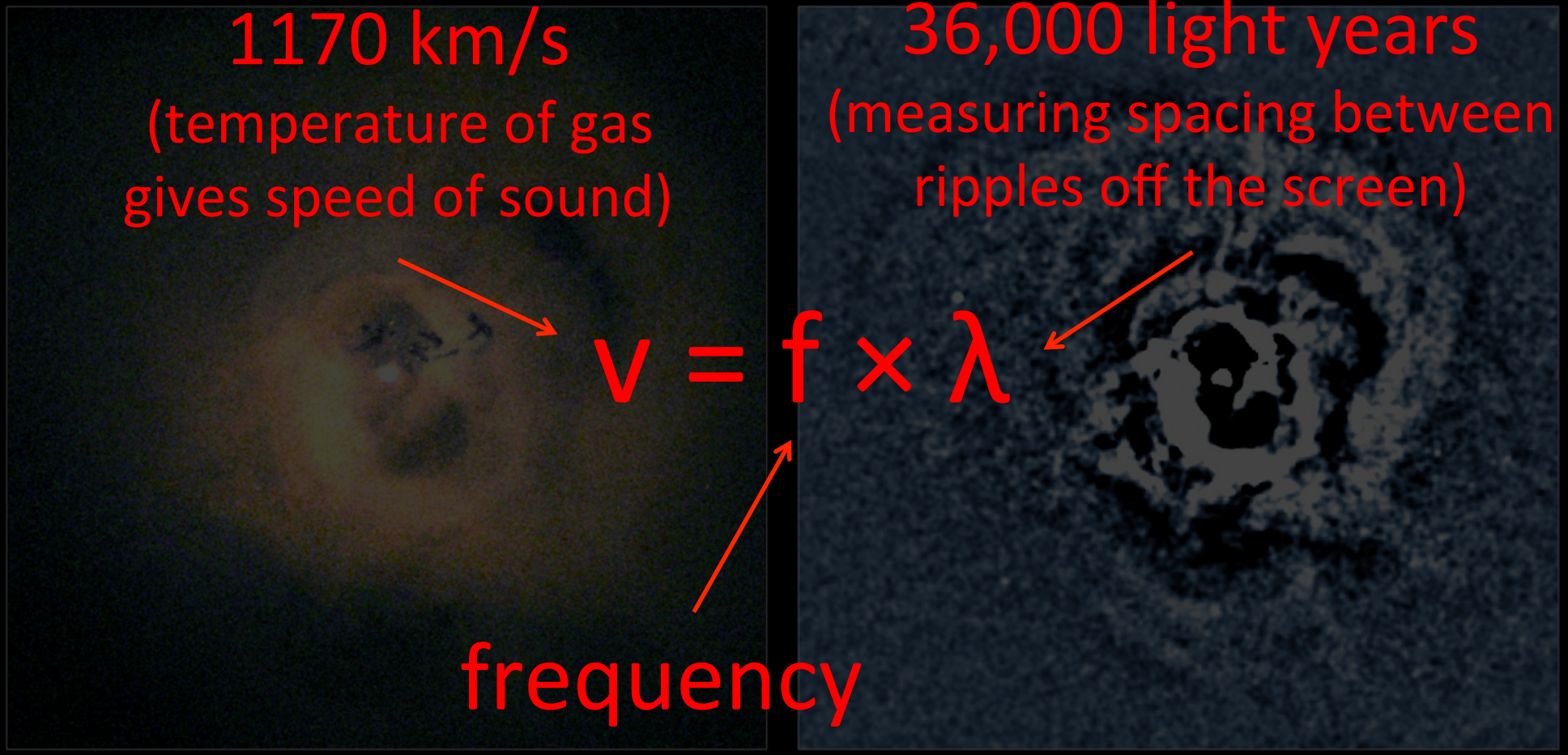
wavelength

$$v = f \times \lambda$$

frequency

NASA/CXC/IoA/A Fabian et al.

The Deepest Note: A Supermassive Black Hole



NASA/CXC/IoA/A Fabian et al.

The Deepest Note: A Supermassive Black Hole

- $v = 1170$ km/s $= 1.170 \times 10^6$ m/s
- $\lambda = 36{,}000$ light years
  $= (60$ s/min$) \times (60$ min/h$) \times (24$ h/day$) \times$
  $\times (365.25$ d/yr$) \times (36{,}000$ yrs$) \times (299{,}792{,}000$ m/s$)$
  $= 3.41 \times 10^{20}$ m
- $v = f \times \lambda$
  $f = v / \lambda = (1.170 \times 10^6$ m/s$)/(3.41 \times 10^{20}$ m$)$
  $= 0.00000000000000033$ Hz
- Middle C: 261.626 Hz, and each octave is a factor of 2
- $\log_2(261.626) - \log_2(0.00000000000000033) = 56.14$
  → B ♭ , 56 octaves below middle C !!

NASA/CXC/IoA/A Fabian et al.; clker.com

A Short History of Everything

0 years — The Big Bang

380 thousand years — "Recombination"

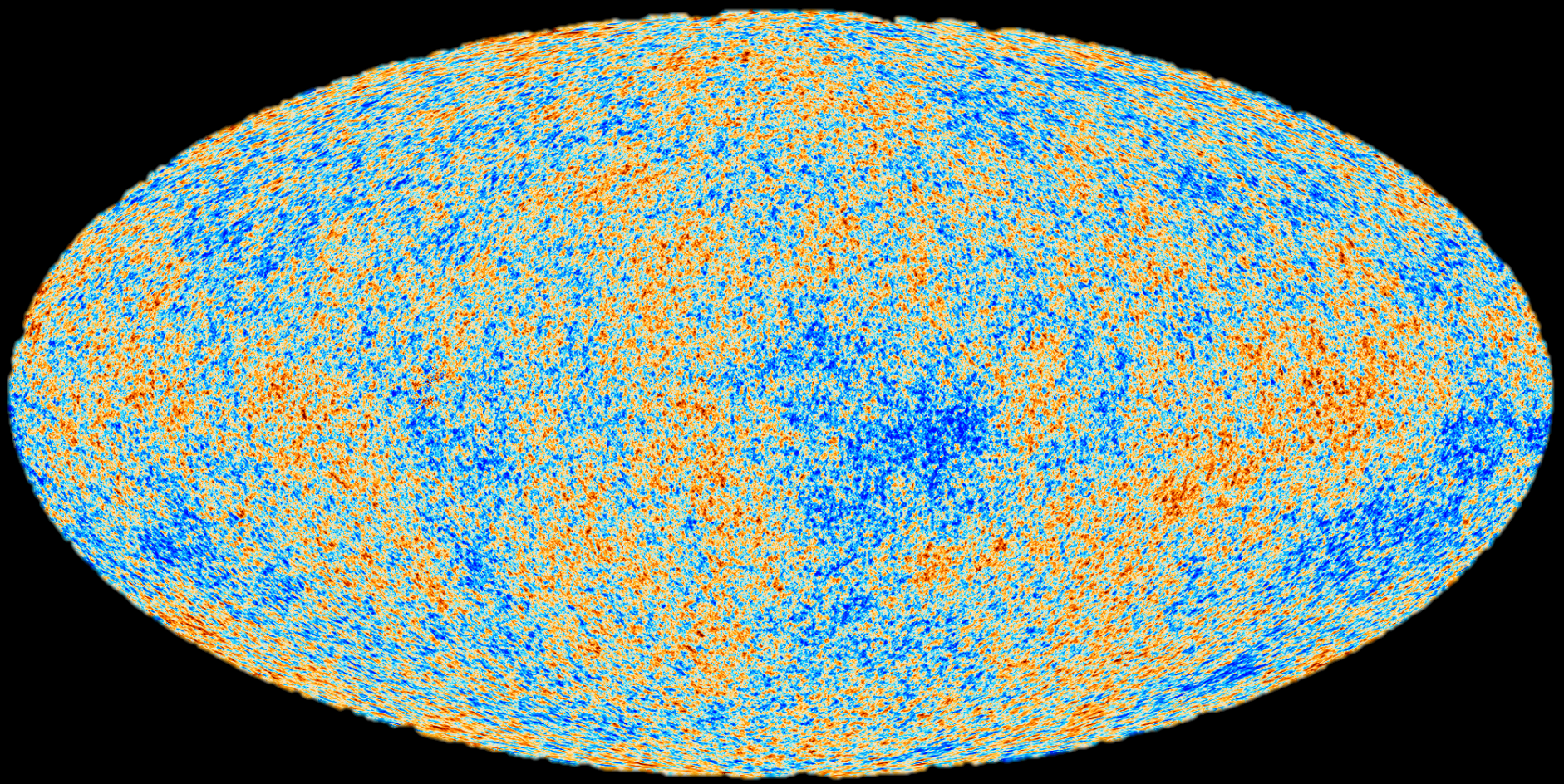
1 billion years — First stars & galaxies form

You are here
(13.7 billion years)

13 billion years — Today: astronomers try to figure it out!

S. G. Djorgovski et al. &
Digital Media Center, Caltech

The First Notes:
The Cosmic Microwave Background



ESA / Planck Collaboration