



Modern Cosmology

Martin Buoncristiani
University of the Third Age
Session 12

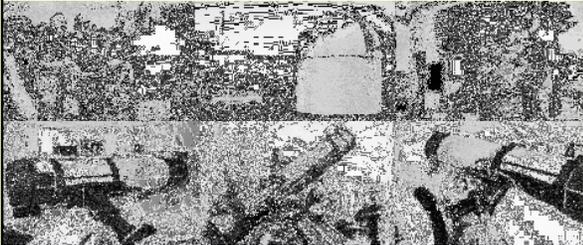
A Long Time Ago in Galaxies Far, Far Away...

Dr. Amanda Bauer
Super Science Fellow
Australian Astronomical Observatory

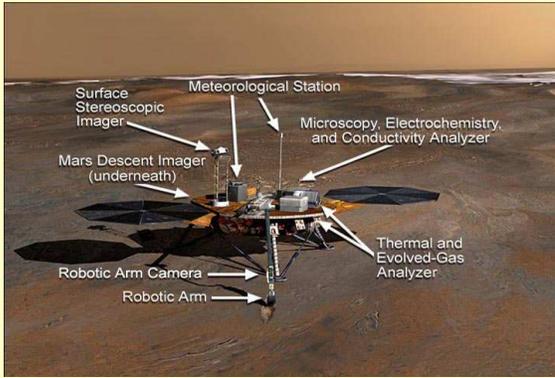


6pm, Thursday
When: 13 September, 2012
Where: To be confirmed

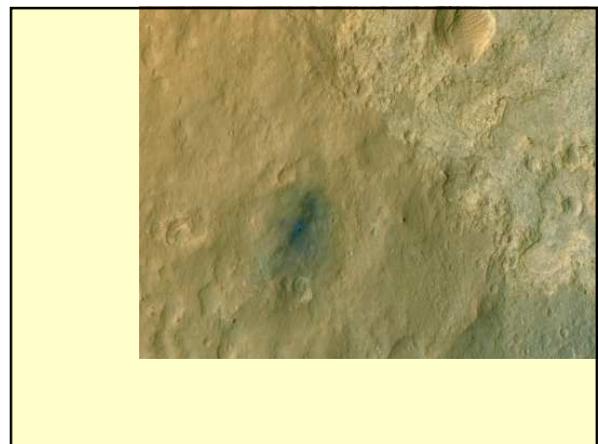
News from Mt. Burnett Observatory

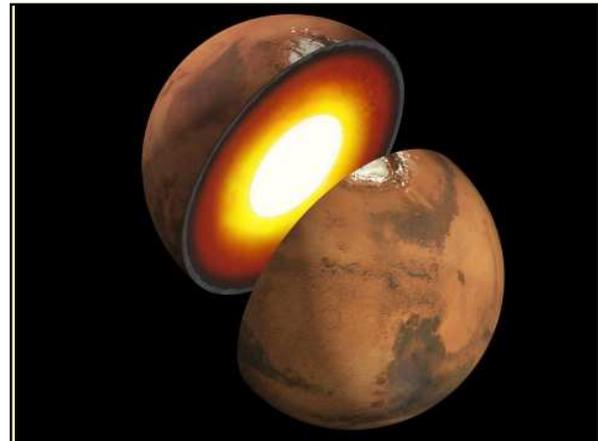
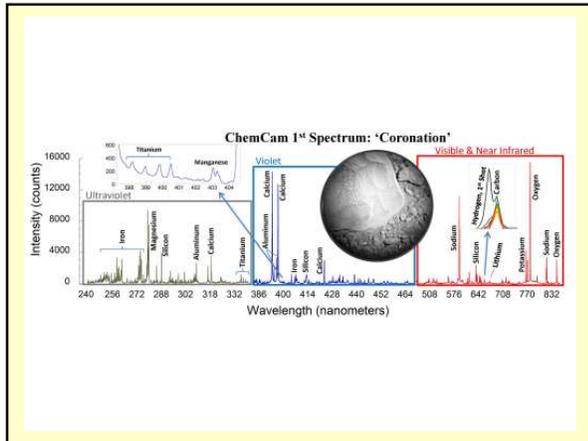


... other News



Surface Stereoscopic Imager
Mars Descent Imager (underneath)
Robotic Arm Camera
Robotic Arm
Meteorological Station
Microscopy, Electrochemistry, and Conductivity Analyzer
Thermal and Evolved-Gas Analyzer





Much of the work was carried out at an optical telescope built in the 1930s

But pulling off the same trick with visible light has seemed unlikely until now. It is the extreme nature of the pair of white dwarf stars known as J0651 - each a substantial As members of the same team [reported in Astrophysical Journal](#) in 2011, the pair orbit each other. Since that discovery, the team has been keenly watching the pair "eclipse" one another, with the pair's orbital period reduce by less than a thousandth of a second. Over a period of 13 months, the team saw the orbital period reduce by less than a thousandth of a second. "A lot of these indirect measurements have taken people years, mostly because the orbits are so tight," says Mr Hermes told BBC News that he liked the idea that such a groundbreaking result was achieved. "There have been 30 years of using radio telescopes and timing pulsars, but this is the first time. The team will continue to watch the pair's tightening orbit, and the expected eclipse time is expected to be in the next few years. These, such as the [proposed eLisa project](#), aim to measure the tiny relative movements of the stars. "It would be a really nice confirmation if we got one of these laser interferometer missions. "We've crunched the numbers, and eLisa would be able to detect this thing in about a week."

More on This Story
 Related Stories
[How the Sun's Core is Heated](#)



Hubble Watches Star Clusters on a Collision Course

Astronomers using data from NASA's Hubble Space Telescope caught two clusters full of massive stars that may be in the early stages of merging. The 30 Doradus Nebula is 170,000 light-years from Earth. What at first was thought to be only one cluster in the core of the massive star-forming region 30 Doradus has been found to be a composite of two clusters that differ in age by about one million years.

The entire 30 Doradus complex has been an active star-forming region for 25 million years, and it is currently unknown how much longer this region can continue creating new stars. Smaller systems that merge into larger ones could help to explain the origin of some of the largest known star clusters. The Hubble observations, made with the Wide Field Camera 3, were taken Oct. 20-27, 2009. The blue color is light from the hottest, most massive stars; the green from the glow of oxygen; and the red from fluorescing hydrogen.

Image Credit: NASA, ESA, and E. Sabbi (ESA/STScI)

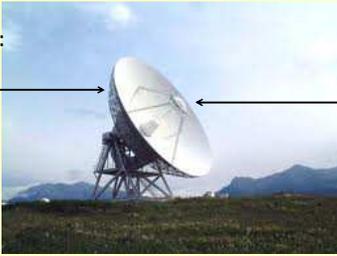


About Radio Telescopes

Detectors of radio waves from space

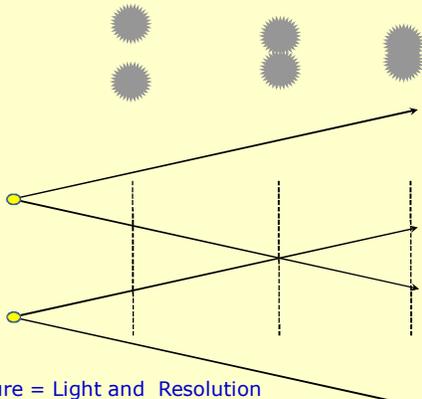
Directional antenna
Mirror plus receiver

Mirrors are:
Plane
Spherical
Parabolic



Receiver

Parkes Observatory (CSIRO) "The Dish"



Aperture = Light and Resolution

Range of the SKA

Frequency (MHz)	Wavelength (m)	Photon Energy (eV)
1	300	4×10^{-9}
10	30	4×10^{-8}
100	3	4×10^{-7}
1000 (1GHz)	0.3 (30 cm)	4×10^{-6}
10,000 (10GHz)	0.03 (3 cm)	4×10^{-5}
100,000 (100GHz)	0.003 (.3 cm)	4×10^{-4}
1,000,000 (1 THz)	0.0003 (.3 mm)	4×10^{-3}

70 MHz
10 GHz

4 m
3 cm

The Radio Telescope Spectrum

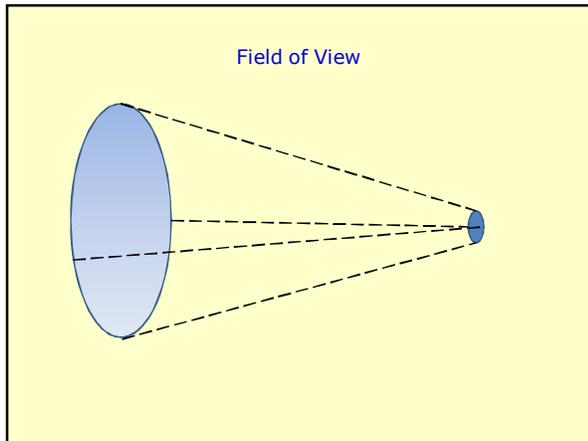
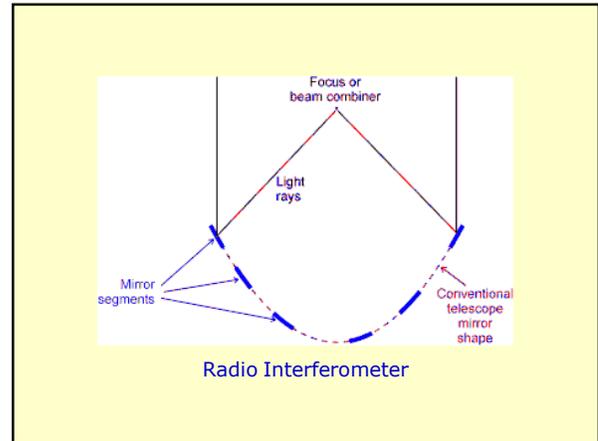
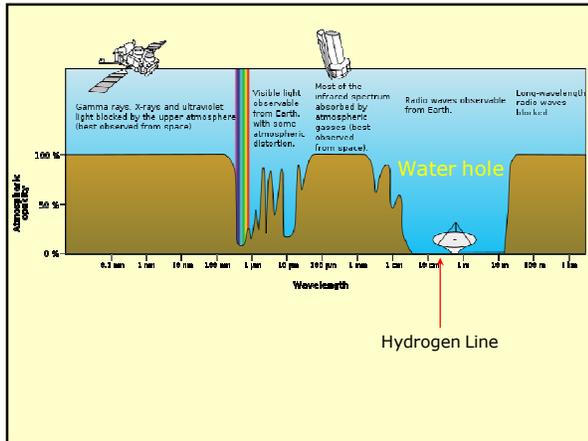
Channel 37 – 608 – 614 MHz
Restricted use of a TV channel in US and Canada

Hydrogen Line 21 cm 1420 MHz
(21.10617405413 cm → 1420.40575177 MHz)



The Water Hole 1,420 – 1,666 MHz
Search for Extra-Terrestrial Intelligence (SETI)

Wilkinson Microwave Anomaly Probe
23, 33, 41, 61, 94 GHz



Aperture Synthesis

Measure both the amplitude and the phase of the incoming wave
 Cannot be done for optical waves

Control the aperture, field of view and steerability

The proposed arrays will increase the precision dramatically
 uncertainty down from 10% to 1 %



The Square Kilometer Array Radio will be the world's biggest telescope
one of the biggest scientific projects ever!

On 25 May 2012 the SKA Organisation announced the SKA would be shared between South Africa and Australia with a majority share going to South Africa.

Artists Conception

Factors In the Decision

Ionosphere Stability and Charged Particles
 Radio Frequency Interference (RFI)
 Troposphere Stability
 Land Features
 Availability of Electric Power
 Costs (infrastructure, transportation)
 Legal Issues (mining rights, indigenous rights, restrictions on new RF sources)
 Social and Political Issues



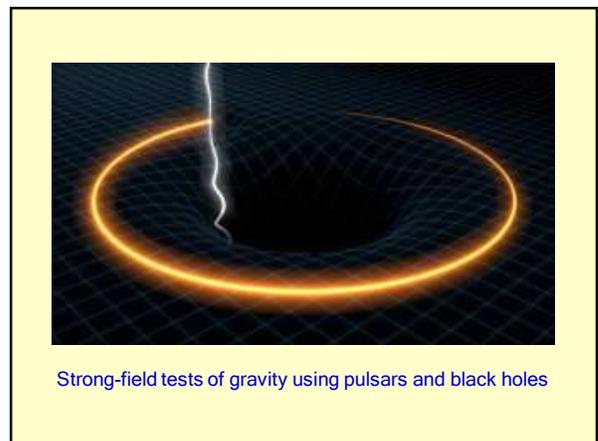
SKA Organisation, headquarters in Manchester, UK.
<http://www.skatelescope.org/>

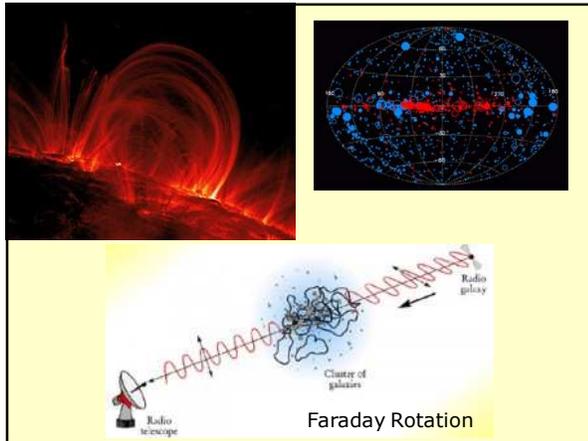
Australia/New Zealand
<http://www.ska.gov.au/Pages/default.aspx>
<http://www.ska.edu.au/>

South Africa
<http://www.ska.ac.za/>

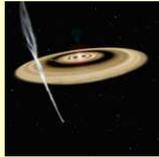


- 1) Investigating galaxy evolution, cosmology and dark energy
 Hydrogen Line 21 cm 1420 MHz
- 2) Strong-field tests of gravity using pulsars and black holes
- 3) The origin and evolution of Cosmic magnetism
 Faraday Rotation
- 4) Cradle of Life Search for life and planets
- 5) Probing the Dark Ages (300,000 to 1 billion years)
 The first stars and black holes
- 6) Unknown opportunities

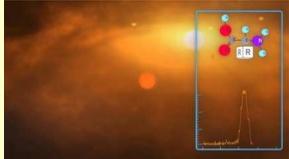
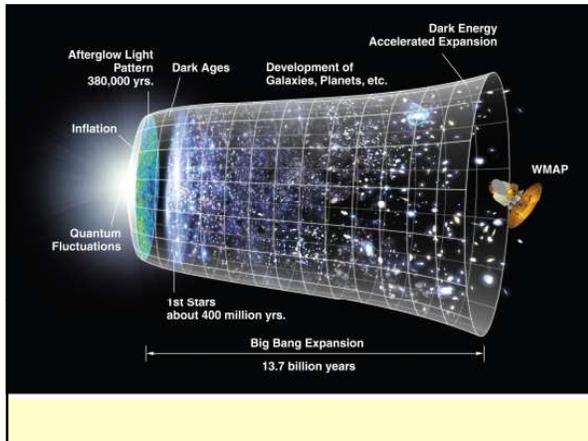




Search for Life and New Planets



Astro-biology

Dark Ages

300,000 yrs	smooth universe recombination first luminous objects appear
500 M yrs	galaxies form re-ionization starts
1 B yrs	re-ionization ends

The Molonglo Observatory Synthesis Telescope (MOST) 843 MHz, operated by the University of Sydney.

modification of the East-West arm of the former *Molonglo Cross Telescope*, a larger version of the Mills Cross Telescope.

MOST is developing technology for the Australian Square Kilometer Array telescope. Since 2003 work has proceeded on the SKA Molonglo Prototype (SKAMP)



What is the Reionization Era?
A Schematic Outline of the Cosmic History

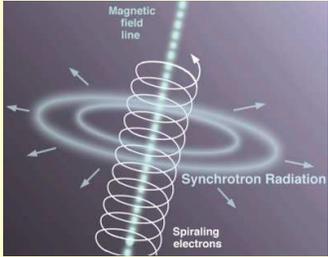
Time since the Big Bang (years)

- ~ 300 thousand: The Big Bang. The Universe filled with ionized gas.
- ~ 380,000 years: The Universe becomes neutral and opaque. The Dark Ages start.
- ~ 400 million years: Galaxies and Quasars begin to form. The Reionization starts.
- ~ 1 billion years: The Cosmic Renaissance. The Dark Ages end.
- ~ 1 billion years: Reionization complete. The Universe becomes transparent again.
- ~ 9 billion years: Galaxies evolve. The Solar System forms.
- ~ 13 billion years: Today. Astronomers figure it all out!

S.D. Doolittle et al. & Digital Media Center, Caltech

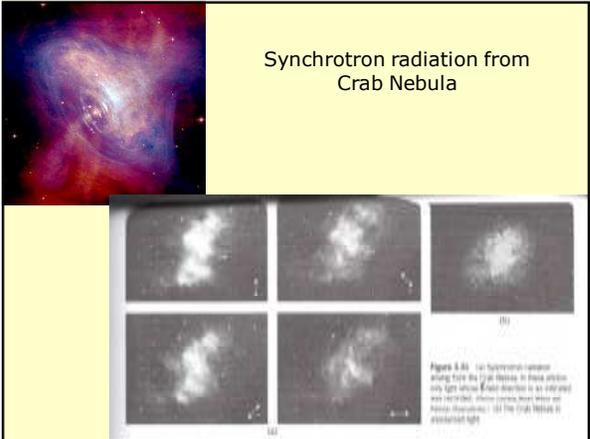
Sources of radio waves from Space

Accelerating charges
for example synchrotron radiation



The diagram illustrates the process of synchrotron radiation. A vertical blue line represents a magnetic field line. A series of white circles, representing electrons, spiral around this line. Arrows point outwards from the spiraling electrons, labeled 'Synchrotron Radiation'. The text 'Spiraling electrons' is at the bottom, and 'Magnetic field line' is at the top.

Synchrotron radiation from Crab Nebula



The top left shows a colorful astronomical image of the Crab Nebula. The bottom right shows a grid of six smaller images, likely representing different observations or components of the nebula's radiation. A small caption is visible in the bottom right corner of the grid.

The world's biggest single aperture Radio telescope is at Arecibo, Puerto Rico

305 meter diameter



An aerial photograph of the Arecibo radio telescope, showing its massive circular dish and the complex support structure of cables and towers.

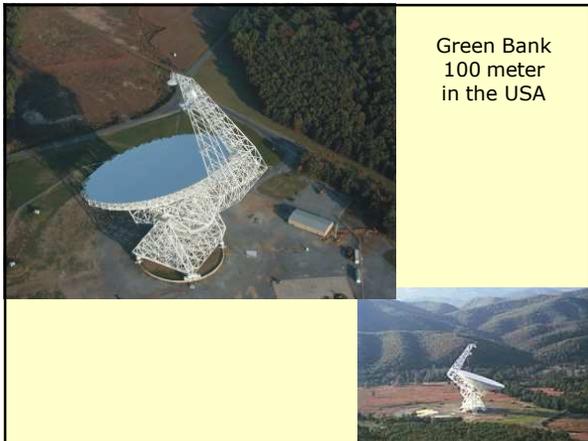
The largest steerable radio telescope in Europe is at Effelsberg, Germany

100 meter diameter



A photograph of the Effelsberg radio telescope, a large white parabolic dish mounted on a tall, white, lattice-like structure, situated in a wooded area.

Green Bank 100 meter in the USA



An aerial photograph of the Green Bank radio telescope, showing the large white dish and its supporting structure in a rural, hilly landscape.

Lovell Telescope at Jodrell Bank, UK



A photograph of the Lovell radio telescope, a large white parabolic dish mounted on a tall, white, lattice-like structure, situated in a rural landscape.