

# ASTRONOMY FOR CAPACITY BUILDING IN AFRICA

**GEORGE MILEY**  
Leiden University

- Vice President International Astronomical Union
  - **Portfolio: Development and Education**
- Chair: 2010 Review Panel for SA NRF Astronomy Institutes
- **What am I going to talk about?**
  - **Astronomy as a tool for development?**
    - **Technological capacity building**
    - **Human capacity building –inspiration**
  - **Importance of EU – Africa partnerships in astronomy**
    - **Strength of South African Astronomy**

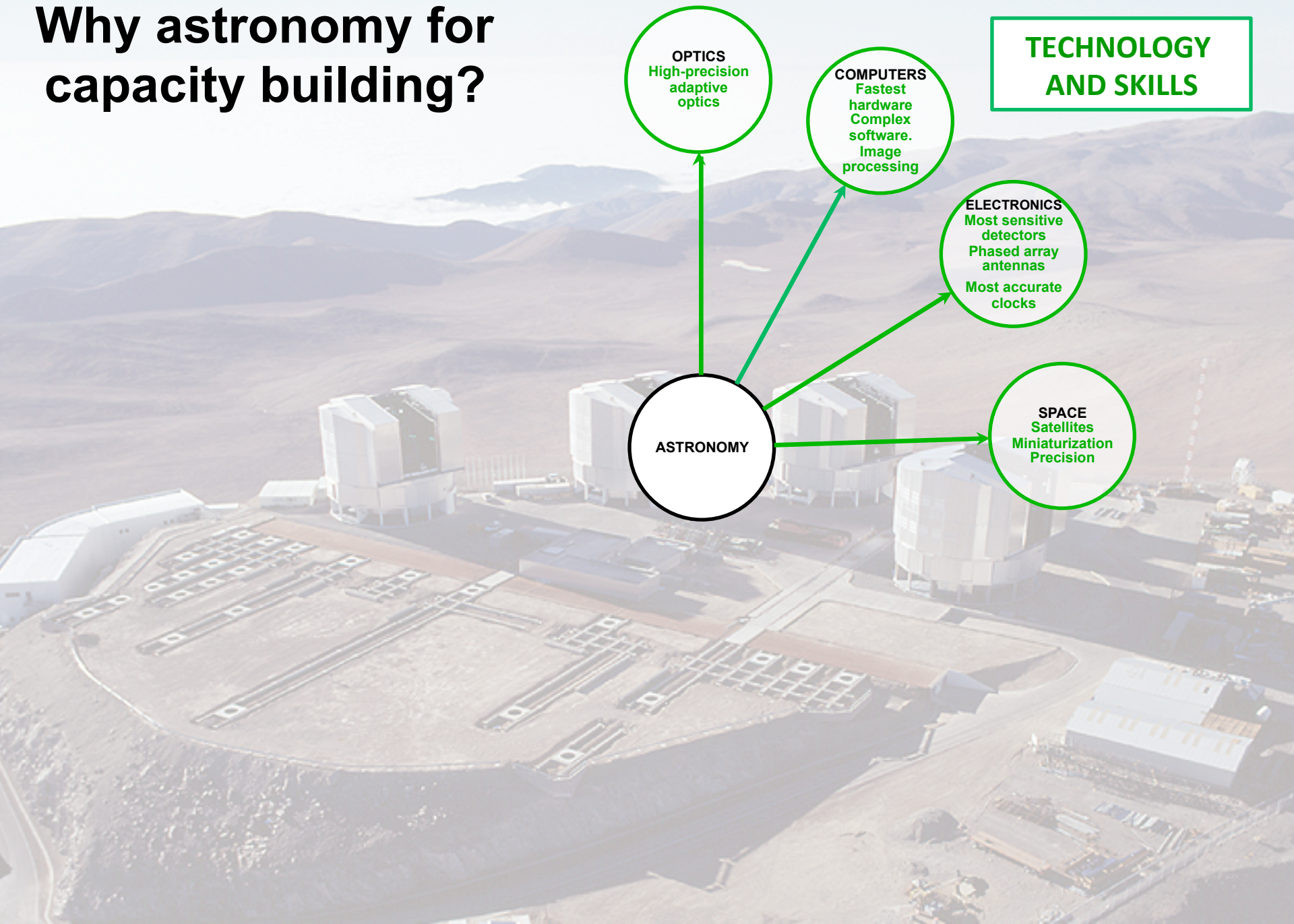
ASTRONOMY IS STUDY OF  
FORMATION AND EVOLUTION OF  
THE UNIVERSE AND EVERYTHING IN IT

Planets  
Stars  
Galaxies  
Exotic objects  
Quasars, Black holes  
Dark matter, Dark energy

FAINTEST OBJECTS  
AT ALL WAVELENGTHS  
PUSHES TECHNOLOGY TO THE LIMIT

ASTRONOMY > TECHNOLOGY DEVELOPMENT

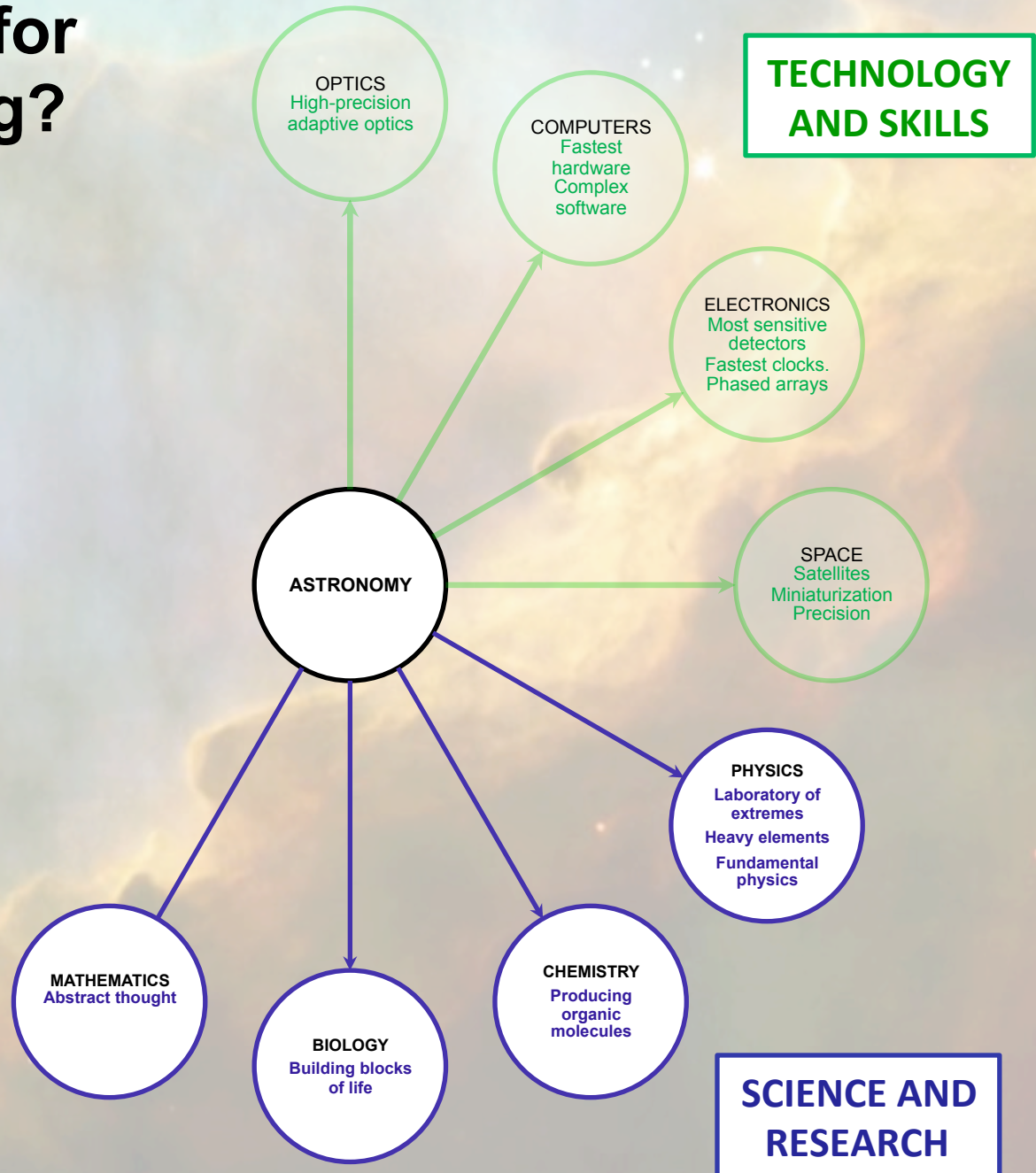
# Why astronomy for capacity building?



# SOME CONTRIBUTIONS OF **RADIO ASTRONOMY** TO TECHNOLOGICAL DEVELOPMENT

Radio Astronomy	Technological Spinoff	Societal Application
Radio Interferometry	Wireless LAN technology Location of wireless sensor nodes	<b>WiFi Internet</b> Location of mobile emergency calls
Very Long Baseline Interferometry Precision astrometry	Most accurate (hydrogen maser) clocks  International celestial reference frame. GPS reference frames	<b>Space communications</b>  Earth orientation parameters, <b>Geodesy &gt; Earth sciences</b>  <b>Spacecraft navigation</b>
Aperture synthesis Image construction	Fourier imaging techniques	<b>Medical imaging tomography</b> Image de-blurring
Homologous antenna design	Precision antennas	<b>Telecommunications</b>
Low Noise Amplifiers	Highly sensitive cryogenically- cooled receiving systems	

# Why astronomy for capacity building?



# ASTRONOMY AS SCIENCE

The background of the slide is a deep red astronomical image. It features a bright, multi-lobed galaxy core in the upper right quadrant, with a long, thin, and slightly curved jet of light extending from it towards the lower left. A smaller, bright core is visible in the lower left quadrant. The overall color palette is dominated by dark reds and oranges, with bright white and yellow highlights at the galaxy cores.

- **Inexpensive laboratories for studying extreme conditions:**
  - Largest energies
  - Largest densities
  - Most tenuous vacuum
  - Largest structures
  
- **Frontier science do-able from anywhere in world**
  - Telescope Archives + PC

# Why astronomy for capacity building?

**CULTURE AND SOCIETY**

**HISTORY**  
Evolution of Universe  
Our roots

**ANTHRO-POLOGY**  
Ancient civilizations  
Our roots

**INSPIRATION**  
Career in science and technology

**ASTRONOMY**

**MATHEMATICS**  
Application of sophisticated formalisms

**BIOLOGY**  
Building blocks of life

**CHEMISTRY**  
Producing organic molecules

**SCIENCE AND RESEARCH**

**PHYSICS**  
Laboratory of extremes  
Making heavy elements

**SPACE**  
Satellites  
Miniaturization  
Precision

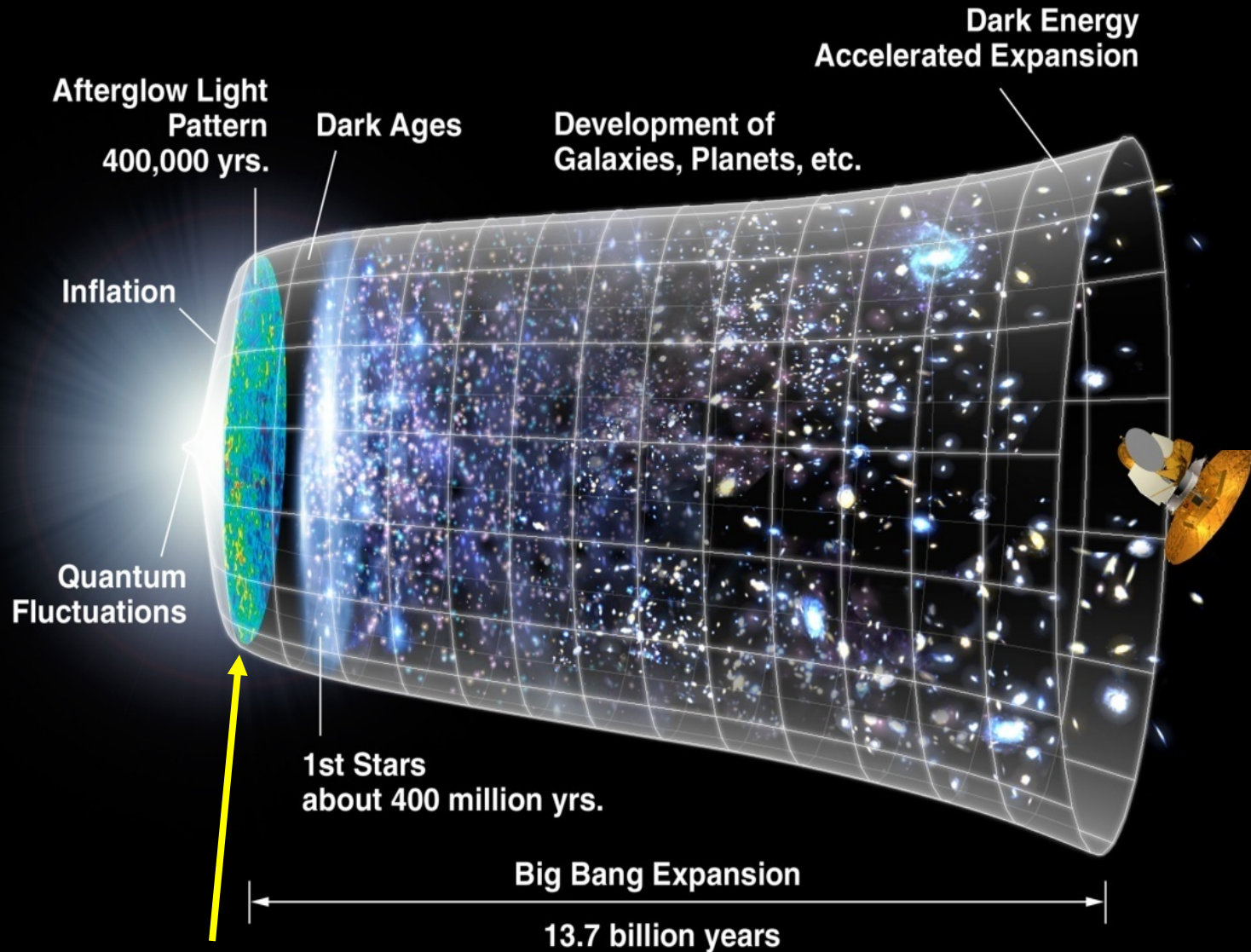
**ELECTRONICS**  
Most sensitive detectors  
Fastest clocks

**COMPUTERS**  
Fastest hardware  
Complex software

**OPTICS**  
High-precision  
adaptive optics

**TECHNOLOGY AND SKILLS**

# HISTORY OF THE UNIVERSE



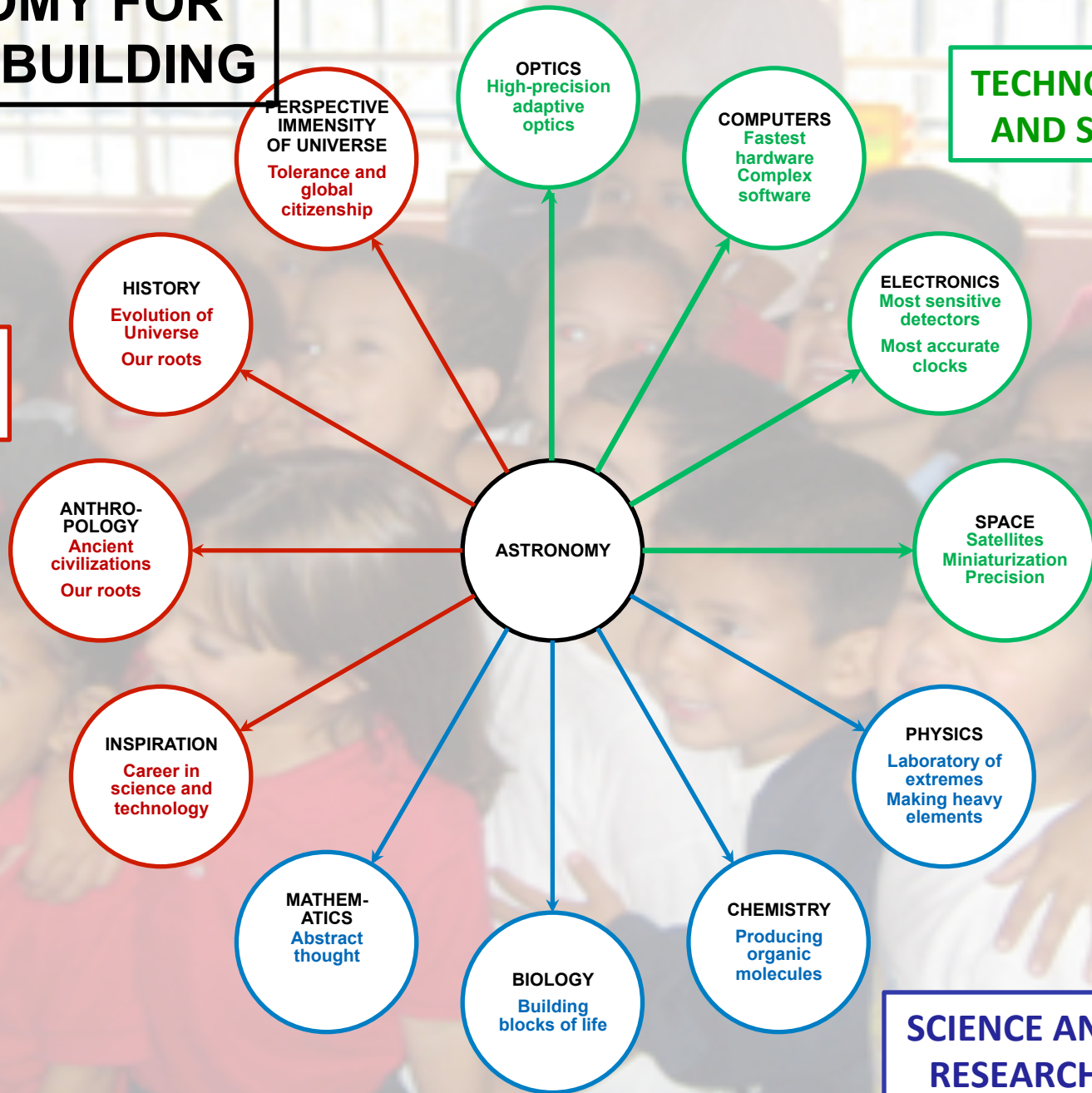
13.7 billion years  
**Everything came out of the Big Bang!!**



# ASTRONOMY FOR CAPACITY BUILDING

## TECHNOLOGY AND SKILLS

## CULTURE AND SOCIETY

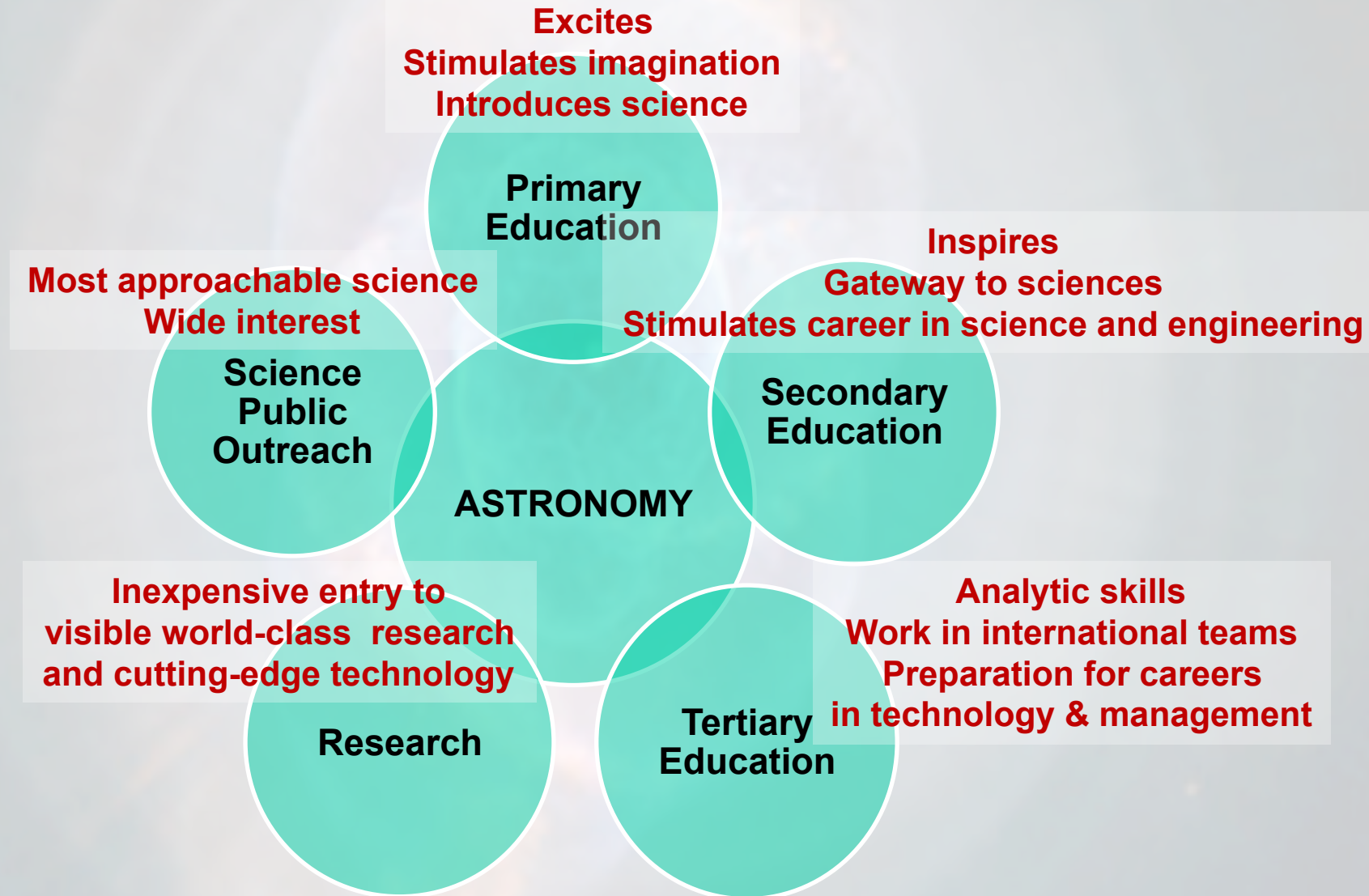


## SCIENCE AND RESEARCH

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# ELEMENTS OF ASTRONOMY FOR CAPACITY BUILDING



# IAU STRATEGIC PLAN

## “ASTRONOMY FOR THE DEVELOPING WORLD”

[http://iau.org/static/education/strategicplan\\_091001.pdf](http://iau.org/static/education/strategicplan_091001.pdf)

### Some Elements

- Long-term Vision
- Goals for 2010 – 2020
- Strategy includes
  - Integrated strategic phased approach
  - Increase regional involvement
  - Emphasis Sub-Saharan Africa
  - Build on International Year of Astronomy
  - Mobilize volunteers
    - Professional + amateur astronomers
    - Teachers
    - Science outreach experts
- Implementation Roadmap
  - Create IAU “Office of Astronomy for Development”



# IAU GLOBAL OFFICE OF ASTRONOMY FOR DEVELOPMENT



- **Global call for proposals**
  - **20 excellent proposals**
    - **5 continents**
  - **SAAO Cape Town selected**
    - **Outstanding research institute**
      - + **pioneering human capacity development programme**
      - Partners IAU-SAAO/NRF
    - **Strong support from SA Department of Science & Technology and Minister**
  - **Inauguration by Minister Pandor 16 April 2011**

# WHY IS SOUTH AFRICA SO GOOD FOR ASTRONOMY?

- **OUTSTANDING SITE** for locating “big-science” astronomical facilities
  - **Geographical advantage - pristine sites for astronomy**
    - SA Astronomy Geographic Advantage Act 2007
- **EXCEPTIONAL SUPPORT** by South Africa for Astronomy
  - **Cutting-edge astronomical infrastructures in Africa**
    - Large optical, radio, X/gamma ray telescopes
- **EXCELLENCE-** Expert internationally-oriented astronomical research community
  - **Strong tradition of astronomical research**
  - **SA Astronomy Astronomical Facilities and Astronomers are outstanding**
    - 2010 Review of NRF AstroGeosciences Facilities
    - New SA Astronomy Agency
    - Building KAT7/MEERKAT is extremely impressive accomplishment
      - July 2011 - Performance Development Review successful

# ASTRONOMY PARTNERSHIPS BETWEEN EUROPE AND SA

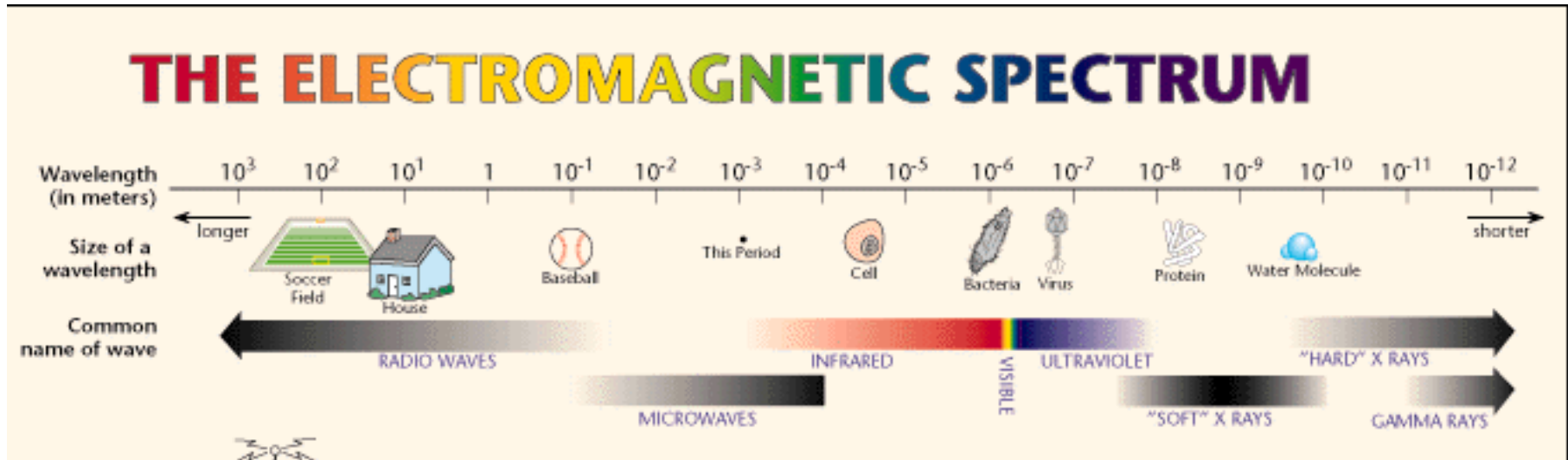
- **Collaborations with EU institutions and scientists**
  - **High-tech Research**
    - SA Facilities (KAT7/MEERKAT, SKA, SALT, H.E.S.S.)
  - **Human Capacity Building**
    - IAU Office of Astronomy for Development
    - EU Universe Awareness
- **Complementarity to Europe**
  - **Accessible sky**
  - **Wavelength coverage of telescopes**
    - Radio, Optical, Gamma-ray
  - **Spatial coverage of radio interferometers**

# EU – SA WAVELENGTH COMPLEMENTARITY

Astronomy is “multi-spectral”

Needs high-tech facilities at all wavebands

“Whole is greater than sum of parts”



e.g. LOFAR (EU) MeerKAT (SA)  
EU Collaborators



SALT (SA)  
EU partners



H.E.S.S. (Namibia)  
EU partners







# MEERKAT

**Most sensitive cm  
telescope in south  
64 antennas by 2015**

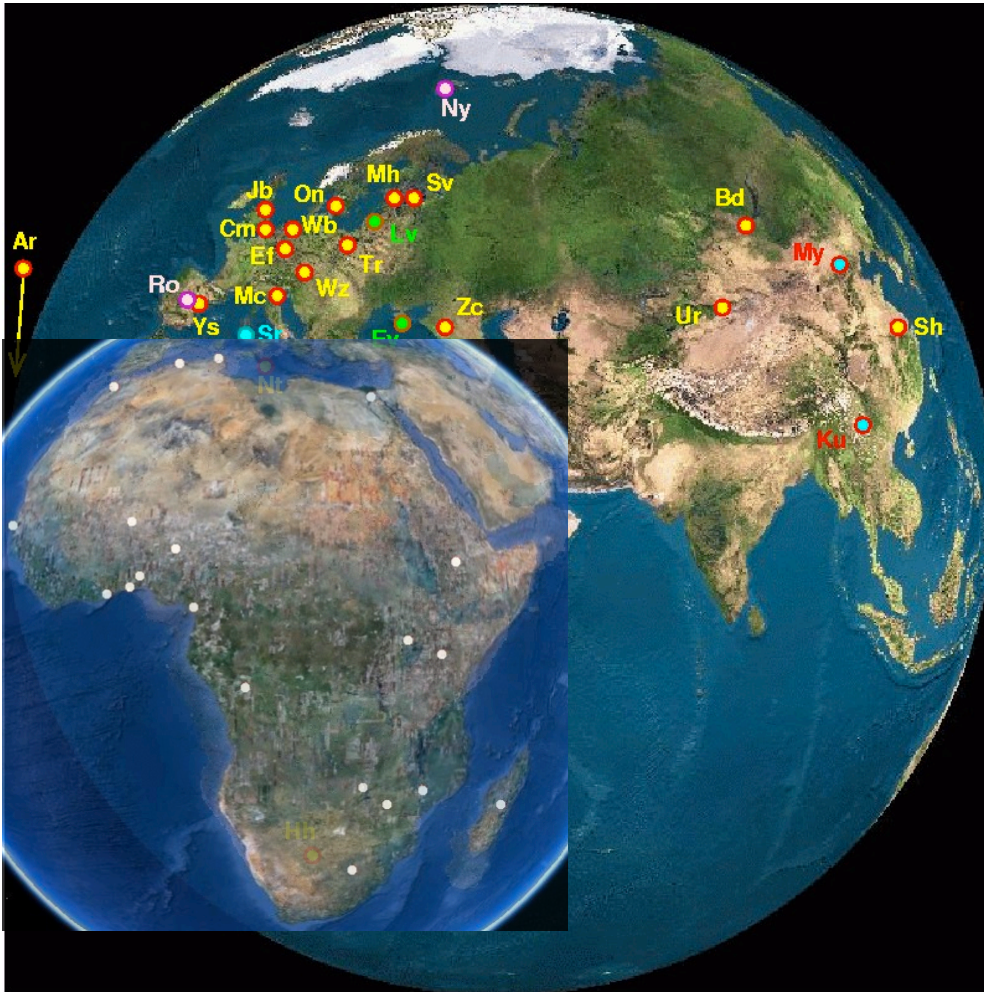
**Exciting scientific programme  
planned**

**KAT-7 Pro-type  
Under commissioning  
and already in demand!**

**Construction was  
substantial feat**

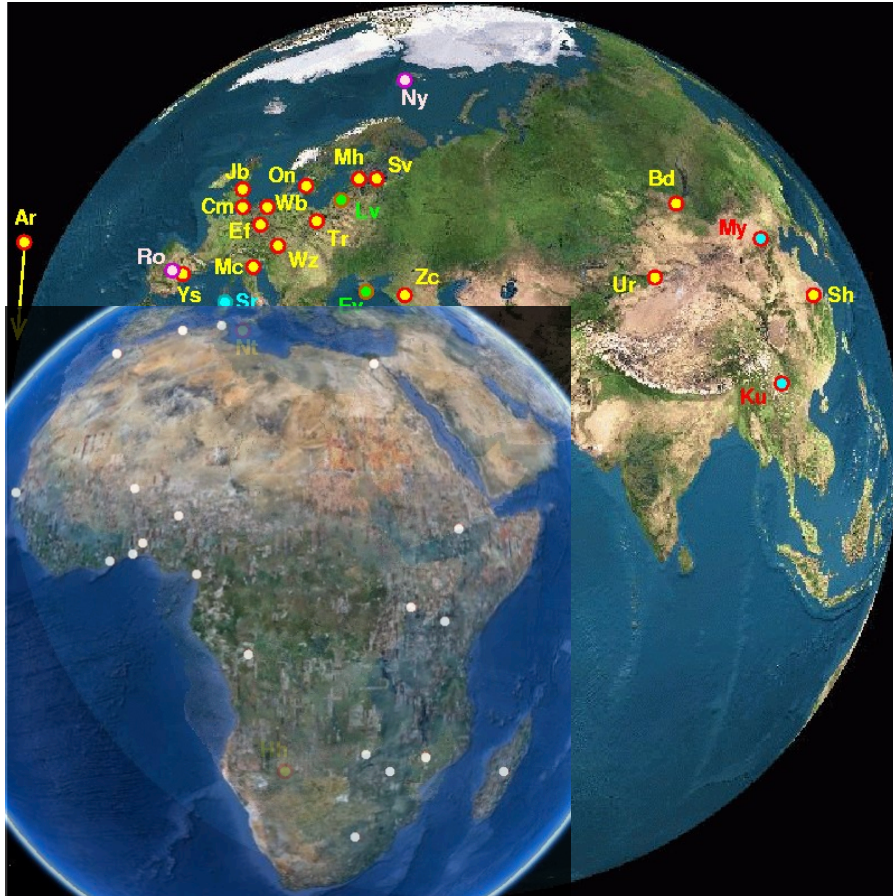
# EU – AFRICA SPATIAL COMPLEMENTARITY

## EUROPEAN VERY LONG BASELINE INTERFEROMETRY NETWORK



- **VLBI > Sharpest astronomical pictures**
  - Sharpness increases with size of array
  - Fidelity increases with density of stations
- **African Array**
  - Retrofit unused communication antennas
  - Huge improvement in both sharpness and fidelity

# NON-ASTRONOMICAL PRACTICAL APPLICATIONS OF ASTRONOMICAL RADIO ARRAYS



- **VLBI Geodesy**

Precision position measurements between points on earth using radio stars

- Tides of the solid Earth and oceans
- Weather and climate
  - Atmospheric structure and dynamics
- Hydrology, Continental water storage
- Mass fluctuations and motions of glaciers
- Ocean and atmospheric circulation
- Monitoring changes in sea level
- Crustal motion, plate tectonics
  - Earthquakes, and volcanos
- Postglacial rebound.

- **Study of ionosphere above Africa**

- Space weather
- South Atlantic Anomaly

# SQUARE KILOMETER ARRAY NEXT-GENERATION RADIO TELESCOPE



- Factor of 10 – 100 more sensitive than present radio telescopes
  - Baselines to 3000 km
  - Revolutionary antenna systems
  - Will drive communication and information technology
  - 67 organisations in 20 countries + industry
  - Target cost 1.5 Billion Euro
- Two possible sites
  - South Africa – Africa
  - Australia – New Zealand
- Pathfinders for science and technology
  - ASKAP (AU), EVLA (USA), LOFAR (EU), KAT7/MEERKAT (SA)
- Decision on site by SKA Founding Board in Q1 of 2012
- IAU is neutral in choice of sites
- SKA will be a powerful engine for global development no matter where it is located

# EXISTING EU-SA PARTNERSHIP IN HUMAN CAPACITY DEVELOPMENT

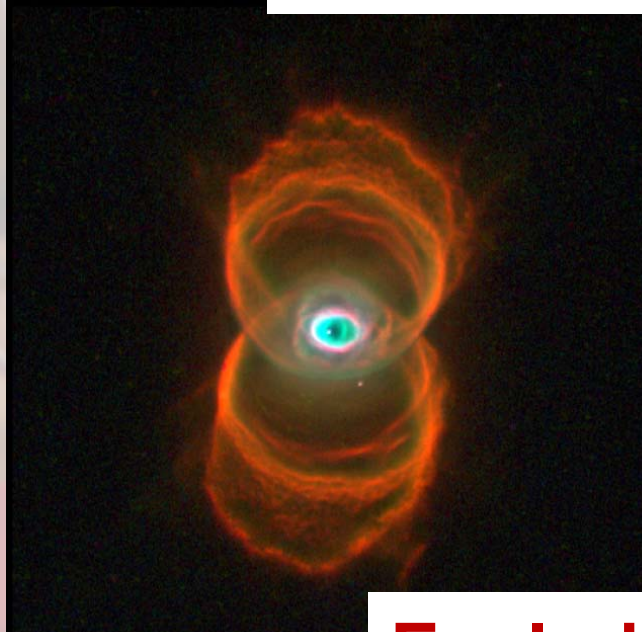


## EU UNIVERSE AWARENESS (EUNAWE) - FP7 PROJECT

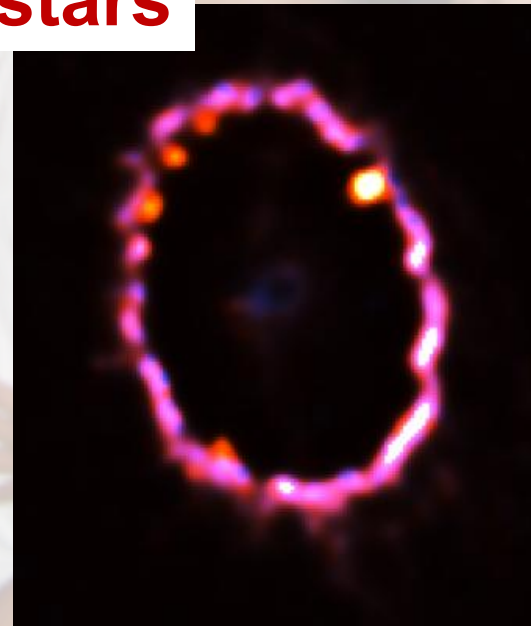
Exposes **UNDERPRIVELEGED** young children (4 – 10) to **INSPIRATIONAL** aspects of astronomy

- Use **PERSPECTIVE, INSPIRATION** and **FUN** of astronomy to
  - Introduce young children to excitement of science
  - Broaden young children's minds
    - Stimulate tolerance and world consciousness
- Implementation in 5 EU member states and South Africa
  - Germany, Italy, Netherlands, Spain, UK (N. Ireland)
  - South Africa
    - National coordinators + materials + teacher training + exchanges

# OUR Universe is exciting



## Exploding stars



# CONCLUSIONS

- **Astronomy – important tool for global development**
  - **Using astronomy for capacity building increases effectiveness of expenditure on astronomy and space research for a tiny fraction of the cost**
- **Complementarity between EU/African radio astronomical research facilities**
  - **On-going collaborations with high potential for expansion**
  - **SA astronomy/ astronomers - extremely high quality**
  - **Building KAT7/ MEERKAT remarkable accomplishment**
- **Important to provide for “Astronomy for Development” collaborative programmes in EU FP8**
  - **Relevant to 7 DGs of the EU Commission**

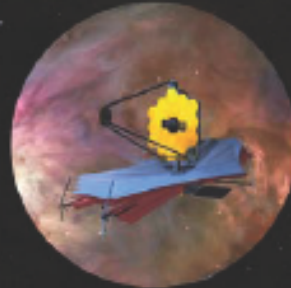
**RADIO ASTRONOMY HAS UNIQUE POTENTIAL  
FOR DEVELOPING AFRICA**

**SUBSTANTIAL SIMULTANEOUS BENEFIT FOR EUROPE**

Culture



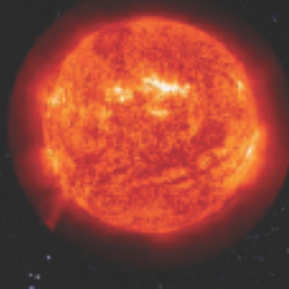
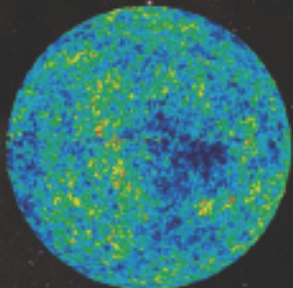
INSPIRATION



Technology



Science



# RATIONALE OF SOUTH AFRICA FOR ASTRONOMY

- 1996 DACST white paper on role of pure science within the new democracy:
  - “It is important to maintain a basic competence in ‘flagship’ sciences such as physics and astronomy for cultural reasons. Not to offer them would be to take a negative view of our future – the view that we are a second-class nation, chained forever to the treadmill of feeding and clothing ourselves”