ASTRONOMY FOR CAPACITY BUILDING IN AFRICA

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– 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?

- **OPTICS**
  - High-precision adaptive optics

- **COMPUTERS**
  - Fastest hardware
  - Complex software
  - Image processing

- **ELECTRONICS**
  - Most sensitive detectors
  - Phased array antennas
  - Most accurate clocks

- **SPACE**
  - Satellites
  - Miniaturization
  - Precision

**TECHNOLOGY AND SKILLS**
# Some Contributions of Radio Astronomy to Technological Development

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Why astronomy for capacity building?
• 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?
HISTORY OF THE UNIVERSE

Afterglow Light Pattern 400,000 yrs.

Dark Ages

Development of Galaxies, Planets, etc.

Inflation

Quantum Fluctuations

1st Stars about 400 million yrs.

Big Bang Expansion

13.7 billion years

Dark Energy Accelerated Expansion

Everything came out of the Big Bang!!
ASTRONOMY FOR CAPACITY BUILDING

CULTURE AND SOCIETY

HISTORY
Evolution of Universe
Our roots

ANTHROPOLOGY
Ancient civilizations
Our roots

INSPIRATION
Career in science and technology

PHYSICS
Laboratory of extremes
Making heavy elements

MATHEMATICS
Abstract thought

CHEMISTRY
Producing organic molecules

BIOLoGY
Building blocks of life

TECHNOLOGY AND SKILLS

OPTICS
High-precision adaptive optics

COMPUTERS
Fastest hardware
Complex software

ELECTRONICS
Most sensitive detectors
Most accurate clocks

SPACE
Satellites
Miniaturization
Precision

TECHNOLOGY AND SKILLS

PERSPECTIVE IMMENSITY OF UNIVERSE
Tolerance and global citizenship
## SOME CONTRIBUTIONS OF RADIO ASTRONOMY TO TECHNOLOGICAL DEVELOPMENT

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ELEMENTS OF ASTRONOMY FOR CAPACITY BUILDING

Primary Education
- Excites
- Stimulates imagination
- Introduces science

Secondary Education
- Inspires
- Gateway to sciences
- Stimulates career in science and engineering

Tertiary Education
- Analytic skills
- Work in international teams
- Preparation for careers in technology & management

Science Public Outreach
- Most approachable science
- Wide interest

Research
- Inexpensive entry to visible world-class research and cutting-edge technology

ASTRONOMY

Wide interest
• 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”
• 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”

THE ELECTROMAGNETIC SPECTRUM

- LOFAR (EU)
- MeerKAT (SA)
- SALT (SA)
- H.E.S.S (Namibia)

EU Collaborators
EU partners
EU partners
KAT-7 Pro-type
Under commissioning
and already in demand!

Construction was substantial feat

Most sensitive cm telescope in south
64 antennas by 2015

Exciting scientific programme planned

MEERKAT

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 conciousness

- 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
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”