



Space Science and Astronomy Development Progress and Opportunities in Ethiopia

By
Seblu Humne (PhD)

seblu1557@gmail.com

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Outline

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- 3 ESSTI-EORC
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 - Stellar Astronomy Group
 - Solar Astrophysics Group
 - Cosmology Group
- 6 More achievements of *AAR&D* for the past 5-7 years
- 7 Feature Opportunities and plan

1. Overview of Ethiopian Space program

1.1 Entoto Observatory and Research Center (EORC)

- The idea of establishing Entoto Observatory and Research Center (EORC) has been initiated during the establishment of the Ethiopian Space Science Society (ESSS) in 2004.
- The first initiative has set out by ESSS Board members and decided the establishment of Astronomy and Space Science research centers at Entoto and other Highlands of Ethiopia.
- The construction of the center has been started in 2008/2009.
- In January 2013 the center has established an independent research center with name Entoto Observatory and Research Center by 32 public universities, ESSS and Unity University to utilize and administer.

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- The mandate of EORC is leading **research and training** in astronomy and astrophysics, space science, Earth Observation, satellite science and related science and technology as well as national and international collaboration.
- It is the first and the only institute working on astronomy, space science and applications, satellite technology and Earth Observation in Ethiopia.
- Entoto Observatory and Research Center is engaged in:
 - 1 Research
 - 2 Postgraduate program (MSc & PhD)
 - 3 Outreach program
 - 4 Observation

1.3 ESSTI

- On October 14, 2016, the Council of Ministers approved the Establishment of Ethiopian Space Science and Technology Institute (ESSTI).
- The main objectives of Establishment of ESSTI are:
 - ① To enable the country to fully exploit multidimensional uses of space science and technologies;
 - ② To produce demand based knowledgeable, skilled attitudinally matured professionals in the field of space programs.
 - ③ To develop and strengthen space science and technology infrastructures to speed up space science and technology development in the country and
 - ④ Enable the country to be robust contributor for the development of aerospace science and technology.

Cont...

Research centers

EORC

- Astronomy and Astrophysics research and dev't dept
- Geodesy and Geo-dynamic research and dev't dept
- Remote sensing research and dev't dept
- Space science and application research and dev't dept

Aeronautics and Astronautics

- HPC and data administration directorate
- Satellite dev't and operation research directorate
- Space affairs, registration, inspection, monitoring and license
- Space engineering research and dev't directorate
- Space policy directorate

2. Major achievements of the ESSTI-EORC in the past 5-7 years

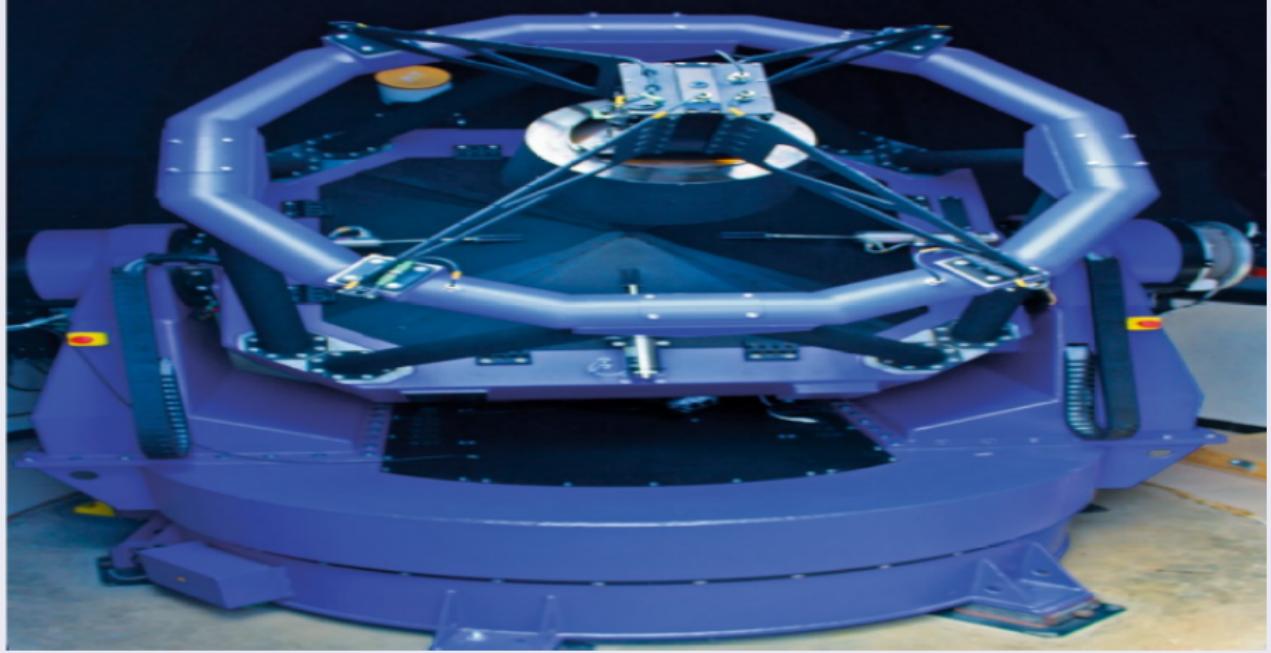
- EORC: Currently consisting of twin, well-instrumented, 1m telescopes (Photometry and Spectroscopy), observational optical astronomy has been enabled.
- These instruments are designed to support both training of student in observational astronomy, but will also provide significant research capability.
- Although the EO is close to a city, with consequent issues of light pollution, the skies are not so bright as for a similar city in other parts of the world.

2.1 EO Telescopes



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EO 1-m ASTELCO telescope



2.2 Satellite



Cont...

ET-SMART-RSS



Cont...

- ESSTI launching its 7.3 metres multi-satellite tracking and data receiving ground station



2.3 Human Resources

- Under ESSTI-EORC:

- ① Astronomy: 5Msc, 3BSC Engineering and 5 PhD
- ② Remote Sensing: 3Msc and 4 PhD
- ③ Space Scinece: 3Msc and 4PhD
- ④ Geodesy and Geodynamics: 4 Msc and 1 PhD
- ⑤ Graduated postgraduate Students: more than 23 Msc and 17 PhD.

- item Under ESSTI-EORC:

- ① Space Engineering: 10 Msc and 1 PhD
- ② HPC: 8 Msc
- ③ Satellite: 6 Msc

- Administer Staffs:

- ① 80: Bsc, BA, Msc,

- In general ESSTI has more than 40 Msc and 20 PhD holders ~ 180
- with this human resources the institute has been published more than 200 papers.

3. ESSTI-EORC

3.1 Astronomy and Astrophysics *R&D*

- Major Activities:
 - ① Doing research
 - ② Conducting observations, computational and theoretical Astrophysics
 - ③ Instrumentation development
 - ④ Post-graduate programme (Msc. and Ph.D.)
 - ⑤ Training and outreach programme
- Based on the mission and vision of the institute, AARD is to ensure the science of Astronomy for every one for the explorations the dynamics of astrophysical objects in our universe and modern Astronomy for the development of Space-science and technology.

Cont...

3.2 Space Science and Application *R&D*

- SSARD strive in different scientific researches and technology development.
- The research focus areas until 2022 are putted as:
 - ① Ionospheric and magnetospheric Science
 - ② Atmospheric and Climate Science, Space weather and geomagnetism;
 - ③ Technology and Software Development: Space weather monitoring center, Radio receiver beacon and Weather satellite signal receiver system development project, etc.
- Major Activities:
 - ① Doing research, Post-graduate programme (Msc. And Ph.D.)
 - ② Teaching and advising, Provide training
- Same for Geodesy & Geo-dynamic *R&D* and Remote Sensing *R&D*

4. Development of Astronomy Progress in Ethiopia

4.1 Astronomy and Astrophysics

- **Astronomy** is one of the oldest and most widely recognized sciences, originating with the simple fascination and wonder of the night sky.
- Over the centuries, it has evolved into a physical science where theories are rigorously tested against precise observations (**Ground and space-based telescopes: Optical and Radio Telescope**).
- It can play a unique role in facilitating education and capacity building and in furthering sustainable development throughout the world.
- **Astrophysics** is a branch of space science that applies the laws of mathematics, physics, biology and chemistry to explain the birth, life and death of celestial objects in the universe.

4.2 Overview of Astronomy in Ethiopia

- The department is engaged in various activities in the Institute:

- ① Research
- ② Postgraduate program: **MSc and PhD**
- ③ Popularization, Training and Outreach program
- ④ Observation in the ESSTI-EORC and the country as well.
- ⑤ Research content: Theoretical and Observational

- Human Resources: 11 staff members:

- ① 2-PhD and 3-Msc in computational Stellar Astrophysics
- ② 2-PhD and in Extra-galactic Astronomy
- ③ 1-PhD in Cosmology
- ④ 2-MSc and 3-Bsc in Engineering (for the telescope operations)
- ⑤ Solar Astrophysics by Collaboration

- Staff members who left for PhD and Msc program:

- ① 3MSc in PhD program in Astronomy
- ② 3-Bsc in MSc program: one in Observational Astronomy and two in Aerospace Engineering

4.3 Research thematic areas

4.3.1 Themes

- Currently, the department conducted four major research thematic areas such as:
 - ① Stellar Astrophysics,
 - ② Solar Astrophysics,
 - ③ Galactic and Extra-galactic Astronomy,
 - ④ Cosmology.
- The department is engaged and conducted **Msc and PhD programs** in the ESSTI-EORC and the country as well.

4.4 Post-Graduate Program

- PhD and MSc students in A&A over the past 8 years:
 - ① Currently 41 students (16 PhD and 25 MSc): Graduated 8 PhD and 11 MSc students
- PhD and MSc students in A&A over the past 8 years in each thematic areas such as Stellar Astrophysics, Solar Astrophysics, Galactic and Extra-galactic Astronomy, cosmology:
 - ① Stellar Astrophysics: PhD=9 and MSc=10
 - ② Extra-galactic Astronomy: PhD=3 and MSc=7
 - ③ Cosmology: PhD=2 and MSc=3
 - ④ Solar Astrophysics: 2-PhD by Collaboration
- Graduated MSc and PhD Students:
 - ① Stellar Astrophysics: PhD=3 and MSc=7
 - ② Extra-galactic Astronomy: PhD=1 and MSc=4
 - ③ Cosmology: PhD=2
 - ④ Solar Astrophysics: 1-PhD by Collaboration

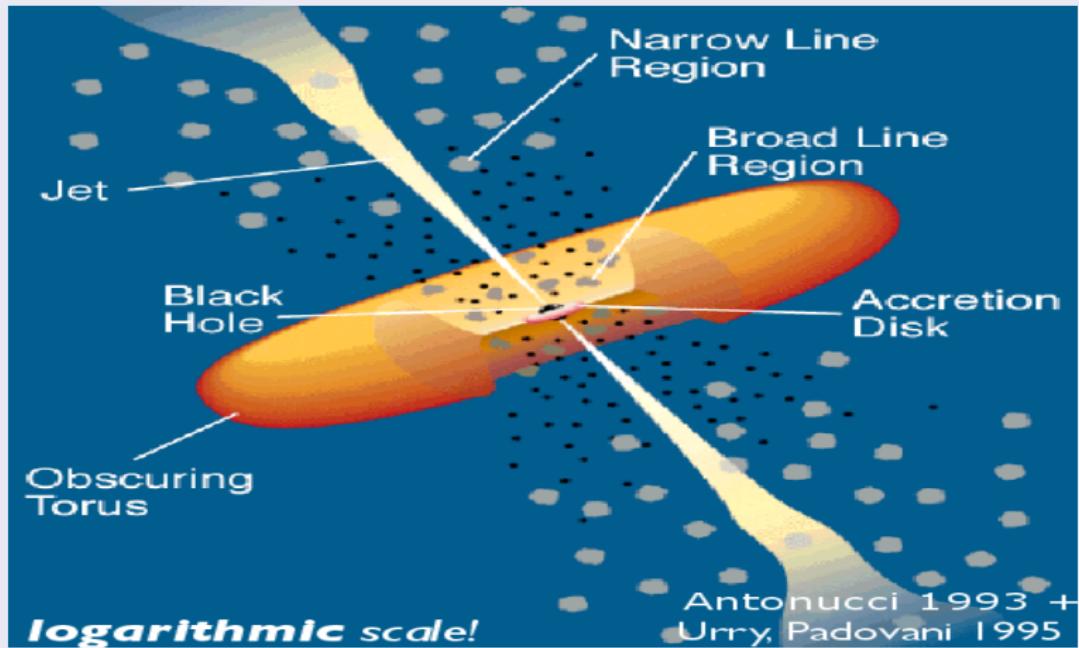
4.5 Extra-galactic Astronomy Group

4.5.1 Research Projects

- Areas of Research under Extragalactic Astronomy:
- Currently, more than 8 projects are running under the Extragalactic Astronomy. These projects are running by the Staff members, Msc and PhD students
- Focused on:
 - ① understanding better the properties of active galaxies, physics behind active galactic nuclei (AGN),
 - ② and the role that nuclear activity has in galaxy formation and evolution across cosmic time.
 - ③ Galaxy morphological classification and evolution
 - ④ Multiwavelength astronomical data System
 - ⑤ Scientific contribution: For researchers and technological development

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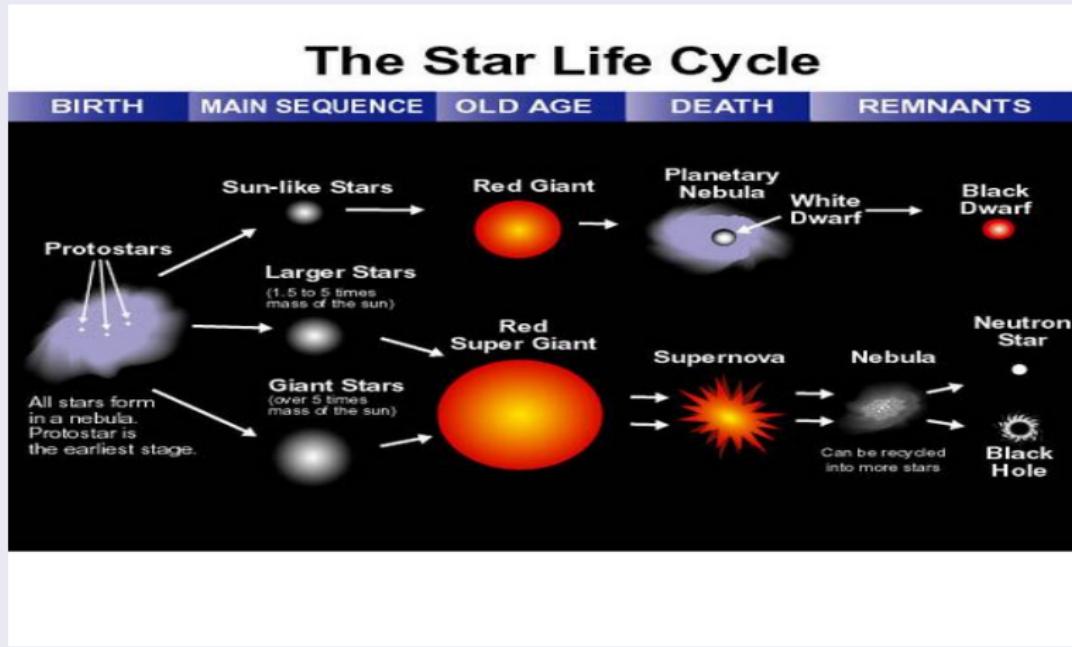
- A picture of the most accepted active galactic nuclei model Credit CM Urry P.



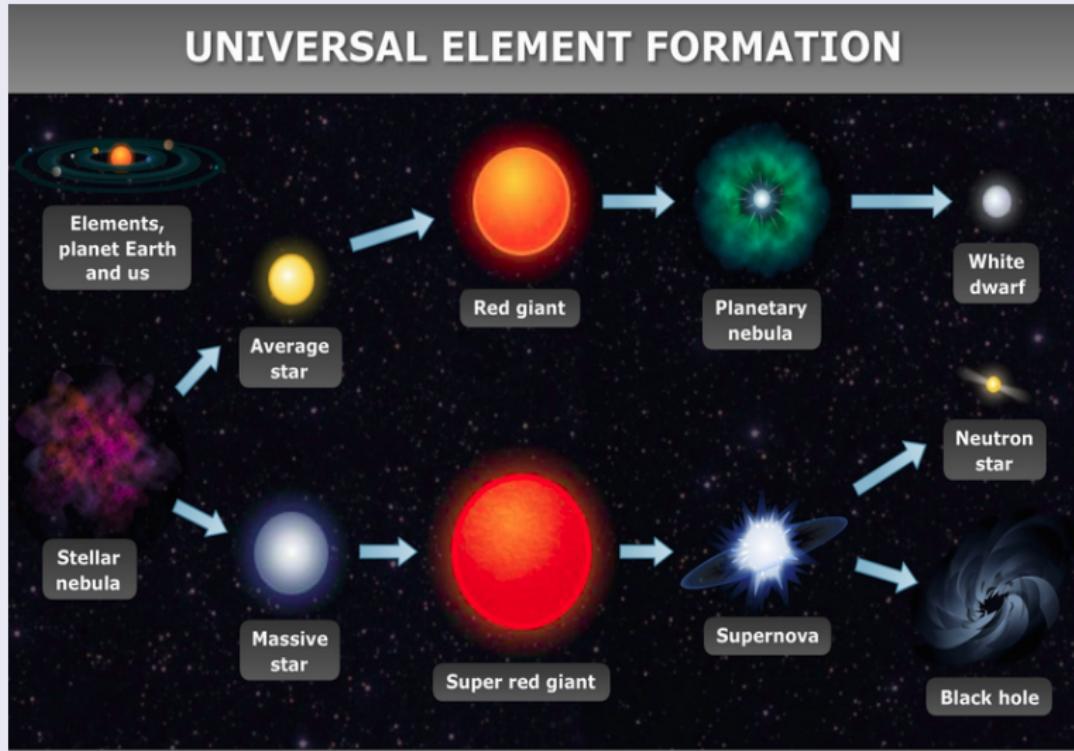
4.6 Stellar Astronomy

4.6.1 Research Projects

- Areas of Research under Stellar Astronomy:

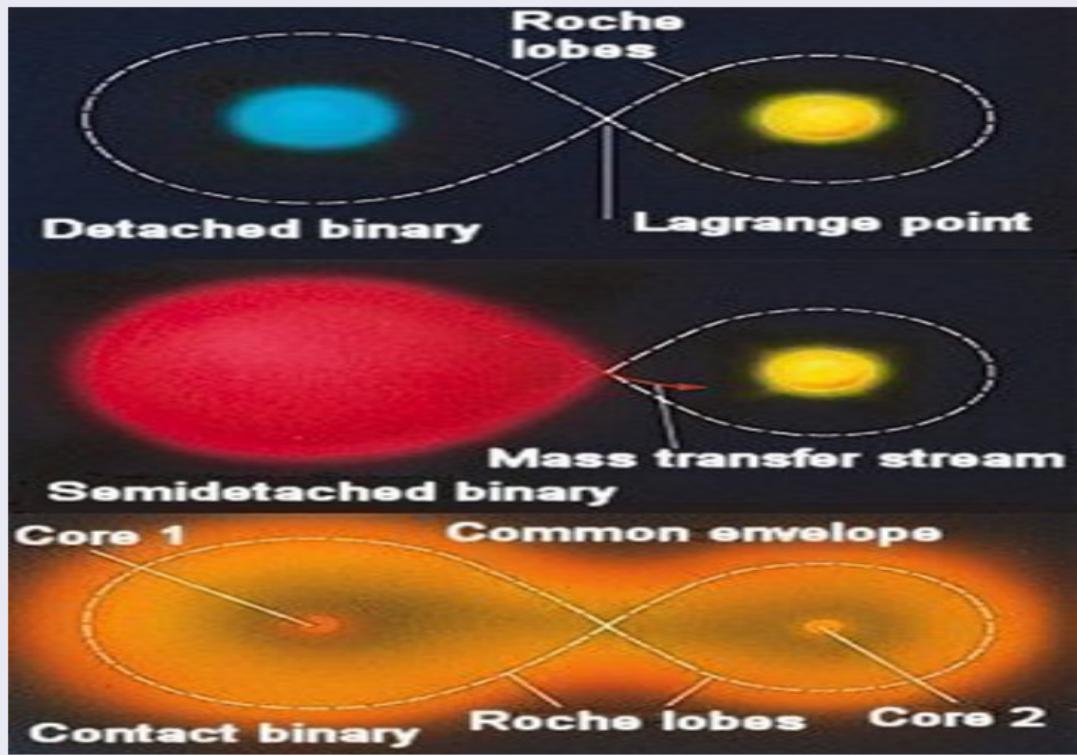


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- Binary Stellar Evolution models



Cont...

- Currently, more than 10 projects are running under the Stellar Astronomy.
- These projects are running by the Staff members, Msc and PhD students
- Focused on:
 - ① Study the life cycles of stars: binary and single stars
 - ② and stellar phenomena such as black holes, nebulae (from which stars are born),
 - ③ white dwarfs, supernovas, and pulsars.
 - ④ Physics of compact objects and high energy Astrophysics, etc.

4.7 Solar Astrophysics Group

4.7.1 Research Projects

- Areas of Research under Solar Astrophysics:
- Currently, more than 4 projects are running under the Stellar Astrophysics.
 - item These projects are running by the PhD students in collaboration with USA
- Focused on:
 - ① Solar variability:
 - ② It studies the fundamental causes of solar phenomena that mainly originated from coronal mass ejections (CMEs) and solar flares that affect space weather.etc

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- Research areas Under Solar Astrophysics:



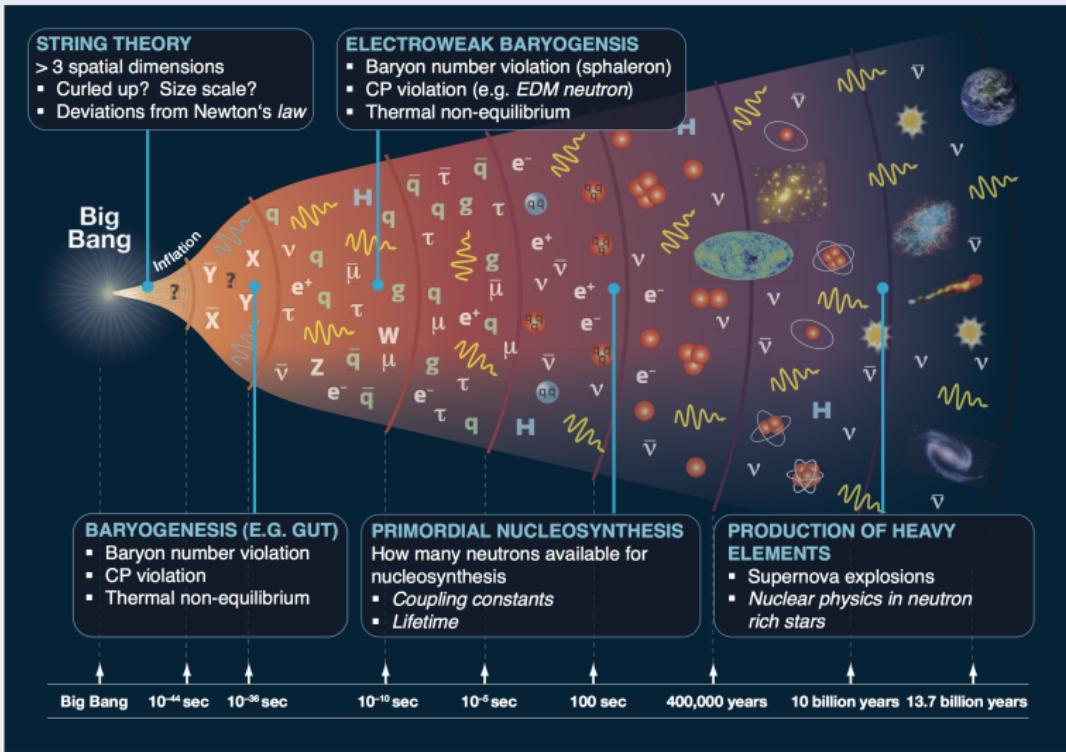
4.8. Cosmology Group

4.8.1 Research Projects

- Areas of Research under Cosmology:
- Currently, more than 8 projects are running under the Cosmology Group.
- These projects are running by the staff members, Msc and PhD students in collaboration with different countries.
- Cosmology is one part of Astronomy Science with the studies of the origin, evolution and the fate of the universe, it deals from the tin dense object (Big Bang) to the large-scale structure to day and the phase of the universe till the near future.

Cont...

- Research areas Under the Cosmology:



4.8.2 Cosmological pros

- What has been achieved so far:

- Dark energy
- Dark Matter
- Inhomogeneity and anisotropic
- Monopole problem
- Horizon and flatness problem (Big-Bang Problem)

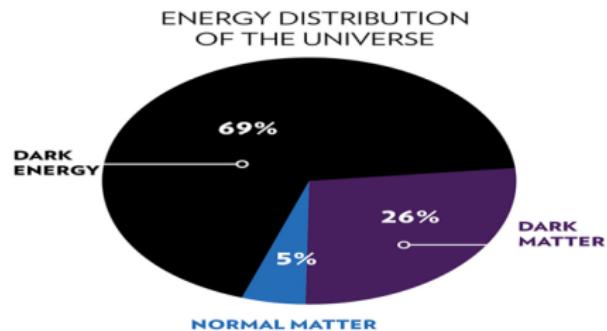


Figure: The components of the entire Universe. Credit: Google Images/ Chandra X-ray Observatory (Jan, 2008)

5. More achievements of AAR&D for the past 5-7 years

- Major achievements:

- ① More than 122 papers are published in reputable Journal
- ② 8 and 11 PhD and Msc students, respectively, were Graduated since 2015-present.
- ③ One Book was published in Cambridge university press.
- ④ Present a talk on Astronomy and space science for EORC visitors from different universities and schools, etc.
- ⑤ Popularization: Outreach program-more than 300.
- ⑥ International Award by Dr. Mirjana Povic.
- ⑦ under Instrumentation unit four technologies were developed such as **Planetary weight scale, 3D printer, Dobsonian Telescope.**
- ⑧ Fundraising proposals and Scholarship for MSc and PhD students including hosting Symposium: more than 100, 000.00 Euro, since 2016-present.

5.1 Main (current) Collaborators

- Main Collaborators-national and international: Education, Research, Development, Outreach program.
- International Collaboration:
 - ① IAU
 - ② Sapin—Msc and PhD
 - ③ Italy—Msc and PhD
 - ④ USA—PhD
 - ⑤ UJ, NWU, Msc and PhD
 - ⑥ Russia——Msc and PhD
 - ⑦ etc.
- National Collaboration:
 - ① AAU—Postgraduate students
 - ② JU,
 - ③ WSU,
 - ④ AMU, MWU, WKU, KMU, BHU, etc.

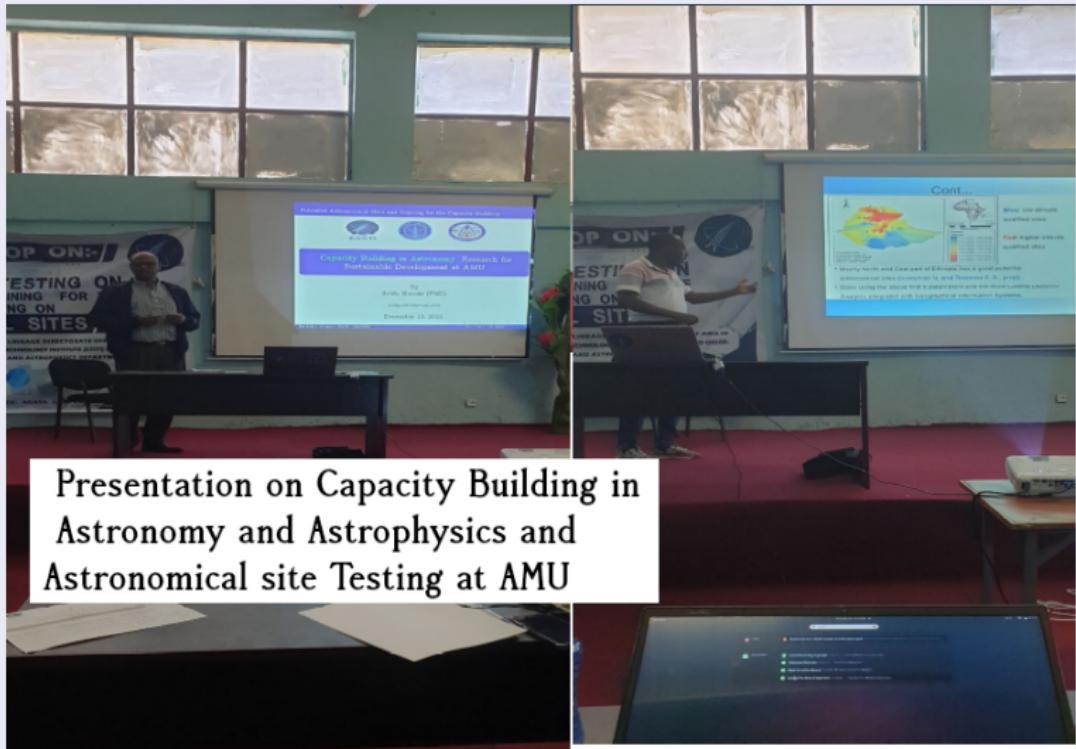
Outreach Program

- Outreach program at AMU: Guge Mountain



Cont...

- Outreach program at AMU: Guge Mountain



Cont...

- Outreach program at AMU: Guge Mountain



keynote speech on Astronomical Site Testing by Dr. Tolera at AMU and support of ESSTI-AARDD at Guge Mountain



- IAU book of proceedings
- European Astronomical Society (EAS) inaugural Jocelyn Bell Burnell
- Inspiration Medal given to astronomers of all career stages whose contribution goes beyond scientific research has been this year given to Dr.Mirjana Povic (ESSTI) for her work on promoting astronomy and science in Africa. EAS award, which gave a lot of visibility to the department and the ESSTI.



5.2.1 Feature Opportunities and plan

- Strengthening the network between ESSTI-EORC and national and international universities in different ways:
- To create the nationwide coordination of astronomy and the fostering of communication and dissemination of **space science and astronomical knowledge** among professional astronomers between two parties.
- To enlarge the number of **professional Astronomers or researchers** in space scince and Astronomy and Astrophysics between ESSTI-EORC and others public organizations.
- To **mobilizing more professional Astronomers** and implementing new programs: MSc and PhD in collaboration with national and International
- To strengthen Indigenous astronomical knowledge in Ethiopia and Africa as well: **Cultural Astronomy. Translation of Astronomy in local Language**
- To work on Research, Outreach program, Postgraduate, projects and Development, etc.

End

Stars and galaxies that can be observed today were born as a result of the evolution of the universe.

Present time
(13.7 billion years
since the Big Bang)

