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Project Title: Development of Fiber Instrument Cable for Prototype AMASE Survey

1. Background

South African Astronomical Observatory (SAAO) is going to develop the fiber instrument cable for the Affordable Multiple Aperture Spectroscopy Explorer (AMASE) survey. AMASE is a planned project that will pair 100 identical multi-fibre spectrographs with a large array of telephoto lenses to achieve a large area integral field spectroscopy survey of the sky at the spatial resolution of half an arcminute and a spectral resolution of R=15,000, covering important emission lines in the optical for studying the ionised gas in the Milky Way and beyond. AMASE spectrographs will cover major optical emission lines, including Halpha, Hbeta, [NII] 6548,6583 A, [SII] 6716,6731 A, [OIII] 5007 A. AMASE will also cover [OI] 6300 A and HeII 4686 A. From these emission line maps of star-forming regions of the Milky way and local group of galaxies in sub-pc to sub-kpc resolution, AMASE will try to understand the physics of galaxy evolution via star formation and its feedback through measurements of emissivity profile, dust extinction, metallicity, ionization parameter, kinematic temperature and turbulence etc. among many others.

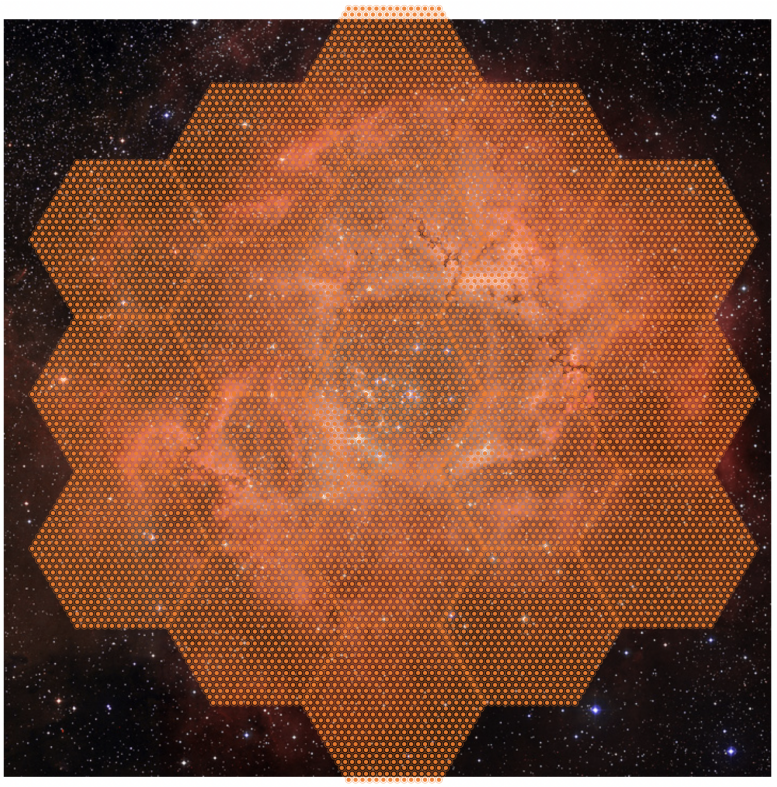

Figure: 19 pointings of AMASE Integral Field Unit to cover the Rosette Nebula. Each circular aperture would provide a spectrum of that location of the Milky Way

2. Aims and objectives of the project

The astrophotonics research laboratory at SAAO is one of the few facilities across the globe dedicated towards developing state of the art astronomical fiber based instrumentation. SAAO astrophotonics group is currently involved in developing multiple instruments for telescopes hosted by SAAO/SALT and UCT. The group consists of professor, astronomer, post-doctoral fellow, and engineer members from SAAO and University of Wisconsin.

Two prototype demonstration versions of AMASE would be developed through the collaboration and

installed in China and South Africa, namely AMASE North and AMASE South. SAAO astrophotonics group will be developing the fibre instrument cable (FIC) for both the AMASE North and South in collaboration with Chinese University of Hong Kong (CUHK). We aim to use the existing facilities and inputs from partner collaboration to perform design, fabrication, assembly and performance validation of the FIC. The detailed objectives are following:

a. Understand focal-ratio-degradation in multi-mode fibers. Using the understanding develop fiber sorting mechanism in order to stress relieve fiber. This involves study of fiber properties and defining the requirements towards design of such mechanisms.
b. Develop and perform opto-mechanical assembly of fibers at the telescope end as an integral field unit. This involves fiber cleaving/polishing, fiber packing and glueing.
c. Develop and perform opto-mechanical assembly of fibers at the spectrograph end as a slit assembly. This involves fiber cleaving/polishing, fiber packing and glueing.
d. Design and assembly of fiber routing from telescope to spectrograph. This involves fiber sorting and fabricating minor tools using the existing 3D printer.
e. Characterization of fiber performance after assembly. This involves mapping of fibers and analysis of fiber optical properties via simple python or similar scripting language.

3. Potential impacts of the project

Several astronomical research bodies including ESO, NASA are encouraging large dedicated surveys to use niche capabilities of instrumentation development to bridge the gap in our understanding of the universe. Along this line of exploration, AMASE survey would greatly advance our understanding of the physics of star formation. Some of the scientific impacts would include:

a. Understanding of mass dependence of star formation rate
b. Better constraining the input spectral energy distribution leading to emission mechanism
c. Advancement of edge buttable 2D area spectrograph
d. Demonstration of small multi-mode fiber application in astronomy
e. Demonstration of CMOS detector application in astronomy

4. Requirements

The student would require a basic grasp of any software language. Understanding of photonics or optical fiber is not necessary and will be built over the duration of the project. However, a keen interest and willingness to learn and apply the knowledge for solving practical problems would be important.