Nurture workshop for B.Sc(Physics) Students

on

INTRODUCTION TO ASTRONOMY

24 - 26 September 2018

at

Sullamussalam Science College, Areekode

Ugrapuram (PO), Malappuram

Kerala

Organized by,

Department of Physics, Sullamussalam Science College, Areekode.

Co-Sponsored by,

Kerala State Council for Science, Technology and Environment (KSCSTE), Thiruvananthapuram

SOUVENIR

CONTENTS

ORGANIZING COMMITTEE

Chief Patron

Prof. N. V. Abdurahman, Manager

Patron

Dr. P. Muhamed Ilyas

Convenor

Mr. Abdul Rahoof K. A.

Chairman

Dr. Mohemmed Shanid. N. A.

Organising Committee Members

Mr. C. A. Safeeque

Mrs. Najiya. K. M.

Mr. Shafeeque Ali. A. K.

Miss. Faseela. K.V

Mrs. Shahina. E

Dr. T. P. Rashid

National Advisory Committee:

Dr. C. D. Ravikumar (Dept. Of Physics, University of Calicut

Dr. Ameen Poyili (S. R. M. Research Institute , Chennai)

Dr. Joe Jacob (Newmans College, Thodupuzha)

Dr. K.Y. Shaju , (Christ College, Irinjalakkuda)

Dr. G.Harikrishnan,(Govt. College, Madappally)

About the College

Our College, Sullamussalam Science College, Areekode is an aided First grade college affiliated to the University of Calicut and re-accredited by NAAC with A-grade. The college is about 30 Km away from Calicut city, in Malappuram District. A Kilometre away from Areekode on the Vazhakkad road, the college campus is located on the picturesque hills of Perumparamba on the banks of the river Chaliyar.

About the Scope of the Workshop

The primary goal of this workshop is to introduce the fundamentals and recent advances in Astronomy to the undergraduate physics students. The recent development in Astronomy is stimulated by both powerful ideas in theoretical physics and powerful instruments developed through physics. With the advent of recent Indian Astronomy missions like AstroSat the opportunities for research in Astronomy and Astrophysics has increased. The proposed Workshop aims at introducing the Astronomy through physics, cultivating a research mind among the undergraduate physics students. The program provides a platform for active discussion and interaction between eminent astronomers and undergraduate physics students. It will be highly beneficent for everyone aiming for a bright career in science in future.

Chief Resource Persons

1. Dr. Anand Narayanan, Associate Professor in Astrophysics, Department of Earth & Space Sciences, Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram
2. Mr. Sarath Prabhav, Secretary, Thiruvananthapuram chapter, Amateur Astronomers Organisation, Kerala

Programme Schedule

DAY-1 (24-09-2018, Monday)

09.30 am – 10.30 am : Inaugural Session

10.30 am – 11.30 am : *Star as a black body*

– **Dr. Anand Narayanan**

11.45 am – 01.15 pm : *Introduction to Astronomical Spectroscopy 1*

Dr. Anand Narayanan

02.15 pm – 03.45 pm : *Introduction to Astronomical Spectroscopy 2*

Dr. Anand Narayanan

04.00 pm – 05.00 pm : *Inter Stellar Medium*

– **Dr. Anand Narayanan**

05.00 pm – 06.30 pm : *Introduction to Astrophotography*

Mr. Sarath Prabhav

07.00 pm – 11.30 pm : *Hands-on-session on Astrophotography*

- Mr. Sarath Prabhav

DAY-2 (25-09-2018, Tuesday)

09.30 am – 11.00 am : *Star Formation 1* **- Dr. Anand Narayanan**

11.15 am – 01.00 pm : *Star Formation* 2 – **Dr. Anand Narayanan**

02.00 am – 03.15 pm : *Stellar Evolution* **- Dr. Anand Narayanan**

03-30 pm – 04.30 pm : *Extra-solar Planets: The New Frontier in Modern Astronomy* – **Dr. Anand Narayanan**

DAY-3 (26-09-2018, Wednesday)

09.30 am – 11.00 am : Presentation by the participants

Chair – **Basim. M.B**

(Asst. Prof, Dept. Of Physics, PSMO College, Tirurangadi)

11.15 am – 01.00 am : Presentation by the participants

Chair **– Basim. M.B**

(Asst. Prof, Dept. Of Physics, PSMO College, Tirurangadi)

02.00 am – 03.30 pm : *Tutorial 1* **- Mohammed Shafi. O**

(Asst. Prof, Dept. Of Physics, PSMO College, Tirurangadi)

03.15 pm – 04.30 pm : *Tutorial 2* **– Muhammed Abdurahiman**

(Asst. Prof, Dept. Of Physics, MES College, Ponnani)

INTRODUCTION TO ASTRONOMICAL SPECTROSCOPY

Dr. Anand Narayanan(Associate Professor in Astrophysics, Indian Institute of Space Science & Technology (IIST) Trivandrum)

Astronomical spectroscopy is the study of astronomy using the techniques of spectroscopy to measure the spectrum of electromagnetic radiation including visible light and radio, which radiates for stars and celestial objects. A stellar spectrum can reveals many properties of stars such as their chemical composition, temperature, density, mass, distance, luminosity and relative motion using Doppler shift measurement. Spectroscopy is also used to study the physical properties of many other types of celestial objects such as planets, nebulae, galaxies and active galactic nuclei.

From spectral lines, astronomers can determine not only the element, but the temperature and density of that element in the star. The spectral lines also can tell us about any magnetic field of the star. The width of the line can tell us how fast the material is moving. We can learn about winds in stars from this. If the line shifts back and forth we can learn that the star may be orbiting another star. We can estimate the mass and size of the star from this. If the lines grow and fade in strength we can learn about the physical changes in the star. The light from the stuff between the stars allows astronomers to study the interstellar medium. This tells us what type of stuff fills the space between the stars. Space is not empty. There is lots of gas and dust between the stars. Spectroscopy is one of the fundamental tools which scientist used to study the universe.

Astronomical spectroscopy is used to measure three major bands of radiation: visible spectrum, radio, and X-ray. While all spectroscopy looks at specific areas of the spectrum, different methods are required to acquire the signal depending on the frequency.

Spectral Type

The spectral type of star is a system of classification of stars based on the star's spectra that correlate with each star's surface temperature and colour. Stars range from blue and hot to red and cool. The seven spectral type are O,B,A,F,G,K and M.

Absorption Spectrum

Most stars are surrounded by outer layers of gas that are less dense than the core. The photons emitted from the core cover all frequencies (and energies). Photons of specific frequency can be absorbed by electrons in the diffuse outer layer of gas, causing the electron to change energy levels. Eventually the electron will de-excite and jump down to a lower energy level, emitting a new photon of specific frequency. The direction of this re-emission however is random. So the chance of it travelling in the same path as the original incident photon is very small. The net effect of this is that the intensity of light at the wavelength of that photon will be less in the direction of an observer.

Emission Spectrum

If an observer is not looking directly at a hot black body source but instead at a diffuse cloud of gas that is not a black body. If this cloud can be excited by a nearby source of energy such as hot, young stars or an active galactic nucleus then the electrons in atoms of the gas cloud can get excited. When they de-excite they emit photons of specific frequency and wavelength. As these photons can re emitted in any direction an external observer will detect light at these wavelengths.

STAR FORMATION

Dr. Anand Narayanan

(Associate Professor in Astrophysics, Indian Institute of Space Science & Technology (IIST) Trivandrum)

Stars are the most widely recognized astronomical objects, and unstable - sometimes burning furiously, other times dying down. These variations cause the star to pulsate and throw off its outer layers, enshrouding itself in a cocoon of gas and dust. What happens next depends on the size of the core .represent the most fundamental building blocks of galaxies. The age, distribution, and composition of the stars in a galaxy trace the history, dynamics, and evolution of that galaxy.

Stars are born within the clouds of dust and scattered throughout most galaxies. A familiar example of such as a dust cloud is the Orion Nebula. Turbulence deep within these clouds gives rise to knots with sufficient mass that the gas and dust can begin to collapse under its own gravitational attraction. As the cloud collapses, the material at the center begins to heat up. Known as a protostar, it is this hot core at the heart of the collapsing cloud that will one day become a star. Three-dimensional computer models of star formation predict that the spinning clouds of collapsing gas and dust may break up into two or three blobs; this would explain why the majority the stars in the Milky Way are paired or in groups of multiple stars.

As the cloud collapses, a dense, hot core forms and begins gathering dust and gas. Not all of this material ends up as part of a star — the remaining dust can become planets, asteroids, or comets or may remain as dust. The larger a star, the shorter its life, although all but the most massive stars live for billions of years. When a star has fused all the hydrogen in its core, nuclear reactions cease. Deprived of the energy production needed to support it, the core begins to collapse into it and becomes much hotter. Hydrogen is still available outside the core, so hydrogen fusion continues in a shell surrounding the core. The increasingly hot core also pushes the outer layers of the star outward, causing them to expand and cool, transforming the star into
a red giant. If the star is sufficiently massive, the collapsing core may become hot enough to support more exotic nuclear reactions that consume helium and produce a variety of heavier elements up to iron. However, such reactions offer only a temporary reprieve. Gradually, the star's internal nuclear fires become increasingly unstable - sometimes burning furiously, other times dying down. These variations cause the star to pulsate and throw

off its outer layers, enshrouding itself in a cocoon of gas and dust. What happens next depends on the size of the core.

For average stars like the Sun, the process of ejecting its outer layers continues until the stellar core is exposed. This dead, but still ferociously hot stellar cinder is called a White Dwarf. White dwarfs, which are roughly the size of our Earth despite containing the mass of a star, once puzzled astronomers - why didn't they collapse further? What force supported the mass of the core? Quantum mechanics provided the explanation. Pressure from fast moving electrons keeps these stars from collapsing.

If a white dwarf forms in a binary or multiple star system, it may experience a more eventful demise as a nova. Nova is Latin for "new" - novae were once thought to be new stars. Today, we understand that they are in fact, very old stars - white dwarfs. If a white dwarf is close enough to a companion star, its gravity may drag matter - mostly hydrogen - from the outer layers of that star onto itself, building up its surface layer. When enough hydrogen has accumulated on the surface, a burst of nuclear fusion occurs, causing the white dwarf to brighten substantially and expel the remaining material. Within a few days, the glow subsides and the cycle starts again. Sometimes, particularly massive white dwarfs (those near the 1.4 solar mass limit mentioned above) may accreted so much mass in the manner that they collapse and explode completely, becoming what is known as a supernova. If the collapsing stellar core at the center of a supernova contains between about 1.4 and 3 solar masses, the collapse continues until electrons and protons combine to form neutrons, producing a neutron star. If the collapsed stellar core is larger than three solar masses, it collapses completely to form a black hole: an infinitely dense object whose gravity is so strong that nothing can escape its immediate proximity, not even light. Since photons are what our instruments are designed to see, black holes can only be detected indirectly. The dust and debris left behind by novae and supernovae eventually blend with the surrounding interstellar gas and dust, enriching it with the heavy elements and chemical compounds produced during stellar death. Eventually, those materials are recycled, providing the building blocks for a new generation of stars and accompanying planetary systems.

STAR AS A BLACK BODY

Dr. Anand Narayanan

(Associate Professor in Astrophysics, Indian Institute of Space Science & Technology (IIST) Trivandrum)

The intention of this topic presentation is that to give an exact concept of black body radiation, its intensity, Planck function, Wein's Displacement law and thus to show that color of a star indicates its surface temperature. A black body is an idealized object that absorbs all electromagnetic radiation it comes in contact with. It then emits thermal radiation in a continuous spectrum according to its temperature. Stars behave approximately like blackbodies, and this concept explains why there are different colours of stars. The Wein's Displacement law shows that stars have surface temperatures of 3000 K $< T <$ 30,000 K and the corresponding range in wavelength at maximum intensity: 1 μm $< \lambda <$ 1000 Å (IR to UV). The spectrum of light radiated by such a black body is described by the Planck function, which defines how much energy coming is out at each wavelength (or wavelength interval) per unit time through unit surface area of the star into unit solid angle of space.

Class	Color	Surface Temperature	Examples of stars
O	Blue	above 30,000	10 Lacertae
B	Blue-White	10,000-30,000	Rigel, Spica
A	Blue-White	7,500-10,000	Vega, Sirius
F	Yellow-White	6,000-7,500	Canopus, Procyon
G	Yellow	5,000-6,000	the sun, Capella
K	Orange	3,500-5,500	Arcturus, Aldebaran
M	Red	less than 3,500	Betelgeuse, Antares

INTRODUCTION TO ASTRO-PHOTOGRAPHY

Mr. Sarath Prabhav

Secretary, Thiruvananthapuram chapter
Amateur Astronomers Organisation,
Kerala

In this session, an insight into the field of astrophotography will be given. Astrophotography is specialized type of photography in which night sky, celestial bodies ,planets ,stars, galaxies etc. are photographed Besides being able to record the details of extended objects such as the Moon, Sun, and planets, astrophotography has the ability to image objects invisible to the human eye such as dim stars, nebulae, and galaxies. This is done by long time exposure since both film and digital cameras can accumulate and sum light photons over these long periods of time.

Photography revolutionized the field of professional astronomical research, with longtime exposures recording hundreds of thousands of new stars and nebulae that were invisible to the human eye, leading to specialized and ever larger optical telescopes that were essentially big cameras designed to record light using photographic plates. Astrophotography had an early role in sky surveys and star classification but over time it has given way to more sophisticated equipment and techniques designed for specific fields of scientific research, with image sensors becoming just one of many forms of senses. Today, astrophotography is mostly a sub discipline in amateur astronomy, usually seeking aesthetically pleasing images rather than scientific data. Amateurs use a wide range of special equipment and techniques.

With a few exceptions, astronomical photography employs long exposure since both film and digital imaging devices can accumulate and light photons over long periods of time. The amount of light hitting the film or detector is also increased by increasing the diameter of the primary optics being used. Urban areas produce light pollution so equipment and observatories doing astronomical imaging are often located in remote locations to allow long exposures without the film or detectors being swamped with stray light.

Astronomical photography was one of the earliest types of scientific photography and almost from its inception it diversified into sub-disciplines that each have a specific goal including astrometry, star catastrophe, stellar classification, Photometry, Spectroscopy, Polarimetry and the discovery of astronomical objects such as asteroids, meteors, comets, variable stars, novae and even unknown planets. These often require specialized equipment such as telescopes designed for precise imaging, for wide field of view (such as Schmidt cameras), or for work at specific wavelengths of light. Astronomical CCD cameras may cool the sensor to reduce thermal noise and to allow the detector to record images in other spectra such as in infrared astronomy. Specialized filters are also used to record images in specific wavelengths.

A brief description about camera and basic photography techniques such as increasing or decreasing aperture, controlling the shutter speed and the selection of appropriate ISO etc. was as the majority of the participants of the workshop weren’t much familiar with photography. Different kind of photos taken with different usage of the camera techniques was shown, so that the concept was deeply inculcated in our minds. The major techniques needed for the nigh photography and astro-photography was effectively described. .

Many photos of stars, galaxies, some planets will be taken. For students, a hands-on section on astrophotography will be arranged. The students will be divided into groups and each group will be provided with a camera and an instructor. The photos taken by all groups will be displayed and necessary suggestions may be given. Finally, to take astrophotography in mobile, a major mobile app would be introduced.

STELLAR EVOLUTION: STAGES IN THE LIFE CYCLE OF STARS

Dr. Anand Narayanan

(Associate Professor in Astrophysics, Indian Institute of Space Science & Technology (IIST) Trivandrum)

Physical Characteristics

Stars are luminous spheres of burning gas that are between 13 and 180,000 times the diameter (width) of the Earth. The Sun is the nearest star to Earth, and is 109 times its diameter. For an object to qualify as a star, it must be large enough for nuclear fusion to have been triggered in its core.

The surface temperature of the Sun is 5,500 °C, with a core temperature as high as 15 million °C. For other stars, the surface temperature can range from 3,000 to 50,000 °C. Stars are predominantly composed of hydrogen (71%) and helium (27%) gases, with traces of heavier elements such as oxygen, carbon, neon and iron.

Some stars have lived since the earliest era of the universe, showing no signs of dying after more than 13 billion years of existence. Others live only a few million years before using up their fuel. Current observations show that stars can grow up to 300 times the mass of the Sun, and be 9 million times as luminous. Conversely, the lightest stars can be 1/10th of the mass, and 1/10,000th the luminosity of the Sun.

Without stars we would simply not exist. These cosmic behemoths convert basic elements into the building blocks for life. The next sections will describe the different stages in the life cycle of stars.

Birth of Stars

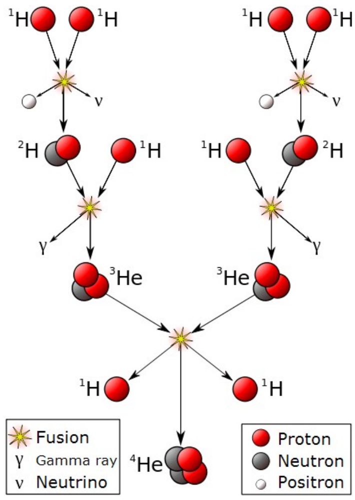
Stars are born when nebulous clouds of hydrogen and helium gas coalesce under the force of gravity. Often a shock wave from a nearby supernova is required to produce areas of high density in the cloud.

These dense pockets of gas contract further under gravity, while accumulating more material from the cloud. The contraction heats up the material, causing an outward pressure that slows the rate of gravitational contraction. This state of balance is called hydrostatic equilibrium.

Contraction comes to a complete stop once the core of the protostar (young star) becomes hot enough for hydrogen to fuse together in a process called nuclear fusion. At this point, the protostar becomes a main sequence star.
Star formation often occurs in gaseous nebulae, where the density of the nebula is great enough for hydrogen atoms to chemically bond to form molecular hydrogen. Nebulae are often called stellar nurseries because they contain enough material to produce several million stars, leading to the formation of star clusters.

The Reaction Fuelling the Universe

Hydrogen gas is predominantly burned in stars. It is the simplest form of atom, with one positively charged particle (a proton) orbited by a negatively charged electron, although the electron is lost due to the intense heat of the star. The stellar furnace causes the remaining protons (H) to slam into each other. At core temperatures above 4 million °C, they fuse together to form helium (4He), releasing their stored energy in a process called nuclear fusion (see picture). During fusion, some of the protons are converted into neutral particles called neutrons in a process called radioactive decay (beta decay).



Life of Stars

The energy released in fusion heats the star further, causing more protons to fuse. Nuclear fusion continues in this sustainable fashion for between a few million and several billion years (longer than the current age of the universe: 13.8 billion years). Contrary to expectations, the smallest stars, called red dwarfs, live the longest. Despite having more hydrogen fuel, large stars (giants, supergiants and hypergiants) burn through it quicker because the stellar core is hotter and under greater pressure from the weight of its outer layers. Smaller stars also make more efficient use of their fuel, as it is circulated throughout the volume via convective heat transport.

If the star is large enough and hot enough (core temperature above 15 million °C), the helium produced in nuclear fusion reactions will also be fused together to form heavier elements such as carbon, oxygen, neon, and finally iron. Elements heavier than iron, such as lead, gold, and uranium, may be formed by the rapid absorption of neutrons, which then beta decay into protons. This is called the r-process for `rapid neutron capture', which is believed to occur in supernovae.

VY Canis Majoris, a red hypergiant star that expels large quantities of gas. It is 1420 times the diameter of the Sun.

Death of Stars

Stars eventually run out of material to burn. This first occurs in the stellar core as this is the hottest and heaviest region. The core begins a gravitational collapse, creating extreme pressures and temperatures. The heat generated by the core triggers fusion in the outer layers of the star where hydrogen fuel still remains. As a result, these outer layers expand to dissipate the heat being generated, becoming large and highly luminous. This is called the red giant phase. Stars smaller than about 0.5 solar masses skip the red giant phase because they cannot become hot enough.

The contraction of the stellar core eventually results in the expulsion of the outer layers of the star, forming a planetary nebula. The core stops contracting once the density reaches a point where stellar electrons are prevented from moving any closer together. This physical law is called Pauli's Exclusion Principle. The core remains in this electron degenerate state called a white dwarf, gradually cooling to become a black dwarf.

Stars of more than 10 solar masses will typically undergo a more violent expulsion of the outer layers called a supernova. In these larger stars, the gravitational collapse will be such that greater densities are reached within the core. Densities high enough for protons and electrons to fuse together to form neutrons may be reached, releasing the energy sufficient for supernovae. The super dense neutron core left behind is called a neutron star. Massive stars in the region of 40 solar masses will become too dense for even a neutron star to survive, ending their lives as black holes.

The expulsion of a star's matter returns it to the cosmos, providing fuel for the creation of new stars. As larger stars contain heavier elements (e.g. carbon, oxygen and iron), supernovae seed the universe with the building blocks for Earth-like planets, and for living beings.

STUDENTS PRESENTATIONS

THE INTERSTELLAR MEDIUM

Ms. Swafvana Mehboob Koonmathodika

(B.Sc. Physics first semester

Sullamussalam Science College, Areekode)

The paper focuses on how interstellar medium is studied, what are its compositions and the gas-star-gas cycle.

If there is beauty in vast extent and sweeping power, then the gas and dust between the stars, called the interstellar medium, could steal worship from the garish stars. The vacuum of space, doesn't mean space is empty; in fact, it is discovered that the interstellar medium is both complex and, when observed at the proper wavelengths, quite beautiful.

The interstellar medium, the gas and dust between the stars, is mostly concentrated near the plane of our Milky Way Galaxy and has an average density of about one atom per cubic centimeter. A nebula is a cloud of gas in space, and an HII region is produced when ultraviolet radiation from hot stars ionizes nearby gas, making it glow like a giant neon sign. The red, blue, and violet Balmer lines blend together to produce the characteristic pink-red color of ionized hydrogen. A reflection nebula is produced by gas and dust illuminated by a star that is not hot enough to ionize the gas. Rather, the dust scatters the starlight to produce a reflection of the stellar absorption spectrum. Because shorter-wavelength photons scatter more easily than longer-wavelength photons, reflection nebulae look blue. The daytime sky looks blue for the same reason. A dark nebula is a cloud of gas and dust that is noticeable because it blocks the light of distant stars. The irregular shapes of these dark nebulae reveal the turbulence in the interstellar medium. Interstellar dust makes up roughly 1 percent of the mass of the interstellar medium. The remaining 99 percent of the mass is gas. About 70 percent of the mass of the interstellar medium is hydrogen gas, and 28 percent is helium. About 2 percent is atoms heavier than helium.

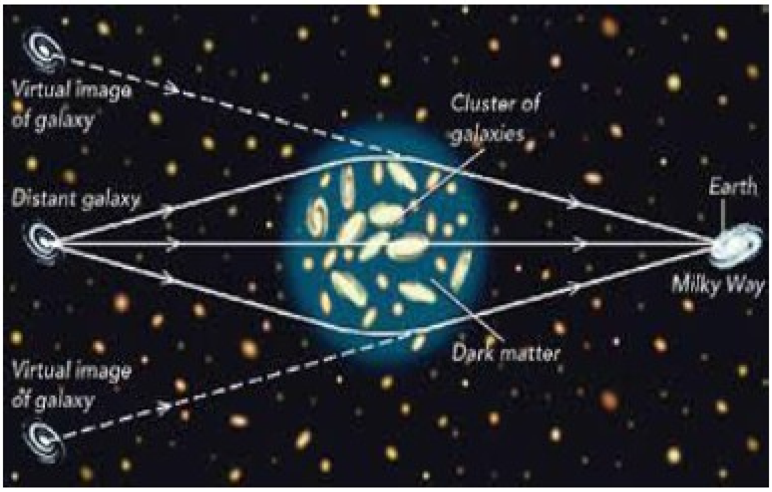
This is approximately the same composition as the sun and other stars. The gas in nebulae has a low density, and the atoms collide so rarely that an electron caught in a metastable level can remain there long enough to finally fall to a lower level and emit a photon. This produces so-called forbidden lines that are not seen in laboratory spectra on Earth where the atoms in the gas collide too often. Interstellar extinction or dimming makes the distant stars look fainter than they should. Interstellar reddening makes distant stars appear too red because dust particles in the interstellar medium scatter blue light more easily than red light. The dependence of this extinction on wavelength shows that the scattering dust particles are very small. The dust is made of carbon, silicates, iron, ice, and other common atoms and molecules. The interstellar gas is cold and has a very low density, and this makes interstellar absorption lines much narrower than the spectral lines produced in stars. Such lines are usually obvious in stellar spectra because they represent ions that cannot exist in the atmospheres of the stars. Interstellar lines stand out in the spectra of spectroscopic binaries because they do not shift their wavelengths as do lines produced by the orbiting stars. Multiple interstellar lines reveal that the light has passed through more than one interstellar cloud on its way to Earth. The low-density gas of the interstellar medium also produces emission lines at many wavelengths. The 21-cm radiation is a forbidden line produced when the electrons in hydrogen atoms change the direction of their spin and emit radio wavelength photons. This radiation allows radio astronomers to map the distribution of neutral hydrogen gas in the interstellar medium. Radio, infrared, and X-ray telescopes have detected emission from over 150 different molecules in the interstellar medium. Interstellar dust, although it is very cold, emits blackbody radiation; and, because the dust in an interstellar cloud has a huge surface area, it can emit large amounts of long-wavelength infrared radiation. The interstellar medium is made up of four main components. HI clouds of neutral hydrogen are cold clouds containing a few solar masses in a region 10 to 150 pc in diameter. They are separated from each other by a hotter but lower-density gas called the inter-cloud medium, and the two generally have similar pressures and are in equilibrium. Large, dense clouds of gas and dust are called molecular clouds because they are so dense molecules can form inside them. Such clouds can be mapped by the radio photons emitted by CO and OH molecules. Hydrogen molecules (H2) do not radiate at radio wavelengths. The largest of these are called giant molecular clouds and are the sites of star formation. Molecules can be broken up by short-wavelength photons, but the dust in molecular clouds scatters these photons and shields the molecules in the inner part of the cloud. Because the molecules are so good at radiating energy away, they keep the clouds very cold. X-ray observations have detected very hot coronal gas, the fourth component of the interstellar medium. It is produced by hot gas blown away from massive stars and gas expelled from supernova explosions. Far-ultraviolet observations show that the sun is located in a local bubble of coronal gas that was apparently produced by a supernova explosion near the sun within the last few million years. The interstellar medium interacts with the stars through a gas-star-gas cycle. Hot stars and supernovae expel gas and dust into the interstellar medium, and cool stars contribute more gas and dust. The gas and dust collects into giant molecular clouds where new stars form singly or in clusters. Star formation ends in a molecular cloud when hot gas from new-born massive stars and supernovae form shock waves and blow the cloud apart. As matter in our galaxy passes through the gas-star-gas cycle, some is trapped in low-mass stars and black holes. Also, more and more hydrogen is converted into helium and heavier elements. In this way, our galaxy is gradually using up its star-making supplies.

DARK ENERGY AND DARK MATTER

Jabir V M

(B.Sc. Physics Final Year, MES College, Ponnani)

Dark matter is an undetected form of mass that emits little or no light but whose existence we infer from its gravitational influence. Dark matter is thought to be 26.8% (84.5% of the total matter) in the universe. It is non-baryonic in nature. Evidence for its existence dates from the 1930s and is very solid. Its evidence is understood from galaxy rotation curves, gravitational lensing (shown in figure), galaxy clusters, etc. Three types of dark matter: cold dark matter, warm dark matter, hot dark matter and their properties will also be discussed. Various unanswered questions like mass of the dark matter, its direct detection, role in the galaxy formation, in what way the dark matter extends the Standard model, etc will be discussed.



Gravitational lensing

Dark energy is an unknown form of energy that seems to be the source of a repulsive force causing the expansion of the universe to accelerate. Evidence for its existence was found only ~8 years ago, and it is much less well-understood. Dark energy is thought to be 68.3% in the Universe. Its evidence is mainly understood from the accelerated expansion of the universe and Galactic Red shift.

WHAT IS GRAVITATIONAL LENSING?

Bhavya

(First Semester B.Sc. Physics

Sullamussalam Science College, Areekode)

Gravitational lensing works in an analogous way and is an effect of Einstein's theory of general relativity – simply put, mass bends light. The gravitational field of a massive object will extend far into space, and cause light rays passing close to that object (and thus through its gravitational field) to be bent and refocused somewhere else. The more massive the object, the stronger its gravitational field and hence the greater the bending of light rays - just like using denser materials to make optical lenses results in a greater amount of refraction.

Gravitational lensing happens on all scales – the gravitational field of galaxies and clusters of galaxies can lens light, but so can smaller objects such as stars and planets. Even the mass of our own bodies will lens light passing near us a tiny bit, although the effect is too small to ever measure.

So what are the effects of lensing? The kind of lensing that cosmologists are interested in is apparent only on the largest scales – by looking at galaxies and clusters of galaxies. When astronomers take a telescope image of a part of the night sky, we can see many galaxies on that image. However, in between the Earth and those galaxies is a mysterious entity called dark matter. Dark matter is invisible, but it does have mass, making up around 85% of the mass of the Universe. This means that light rays coming towards us from distant galaxies will pass through the gravitational field of dark matter and hence will be bent by the lensing effect.

Dark matter is found wherever 'normal' matter, such as the stuff that makes up galaxies, is found. For example, a large galaxy cluster will contain a very great amount of dark matter, which exists within and around the galaxies that make up that cluster. Light coming from more distant galaxies that passes close to a cluster may be distorted – lensed – by its mass. It is the dark matter in the cluster that does almost all of the lensing as it outweighs regular matter by a factor of six or so. The effects can be very strong and very strange; the images of the distant, lensed galaxies are stretched and pulled into arcs as the light passes close to the foreground cluster. The real galaxies are not this shape – they are usually elliptical or spiral shaped – they just appear this way because of lensing.

RECENT DEVELOPMENTS IN ASTRONOMY

Abhishek M S
*(B.Sc. Physics Final Year, MES College**,** Ponnani)*

My presentation encompasses an organized body of knowledge about gravitational waves.
Keen efforts of large number of researchers for about 100 years reward in form of gravitational wave detection in LIGO, which give us a great insight of space-time. Now we have an extra ordinary eye to look deep in events and peep to the universe beyond our traditional observation. My presentation try to draw that story about that long way that gravitational waves propagated from general relativity to ligo, brief summery of chronological development, and subsequent outcoming discovery of LIGO.

KERALA STATE COUNCIL FOR SCIENCE, TECHNOLOGY AND ENVIRONMENT
Sasthra Bhavan, Pattom, Thiruvananthapuram-695 004
Phone no.0471-2548222, 2548220,2548442
www.kscste. kerala.gov.in

KSCSTE an autonomous Institution of Govt. of Kerala is committed for the promotion of Science, Education, Research and Scientific temper in the State. KSCSTE prepares the road map for development of the State through advancements in scientific research and innovation in technologies. Achieving excellence in basic research, academia-industry interactions, strengthening indigenous technologies initiatives, and building strong infrastructure and developing a high quality science education system in the state are our targeted goals. There are Seven R&D centres under the umbrella of the Council to coordinate Research and Development activities in the specific mandated domains.

- *Jawaharlal Nehru Tropical Botanical Garden & Research Institute (JNTBGRI), Palode*
- *Centre for Water Resources Development & Management (CWRDM), Kozhikode*
- *Kerala Forest Research Institute (KFRI), Thrissur*
- *National Transportation Planning & Research Centre (NATPAC), Thiruvananthapuram*
- *Kerala School of Mathematics, Kozhikode*
- *Srinivasa Ramanujan Institute for Basic Sciences (SRIBS), Kottayam*
- *Malabar Botanical Garden & Institute of Plant Sciences (MBG& IPS), Kozhikode*

The major Schemes & Programmes of Council headquarters, located in the State Capital, Thiruvananthapuram are as follows:

KSCSTE FELLOWSHIPS, SCHOLARSHIPS & AWARDS

- *KSCSTE Research Fellowships*
- *Post-Doctoral Fellowships*
- *Emeritus Scientist Scheme for senior Scientists*
- *Fellowships in Science writing & Science Communication*
- *Prathibha Scholarships for Students opting Science learning*
- *Kerala Shastra Puraskaram for eminent scientists*
- *Kerala Science Literature Award*

NEW PROGRAMMES

- *Partnering Academic and Industrial Research (PAIR)*
- *Crafting Young Scientists of Tomorrow (CRYSTAL) programme*
- *Science Education Centre*

FINANCIAL GRANT FOR RESEARCH PROJECTS

- *Science Research Scheme*
- *Engineering & Technology Programme*
- *Ecology & Environment Programme*
- *Intensive programmes for Innovators of Rural Technology and Biotechnology*
- *SARD Scheme focusing activity specific areas*
- *Technology Development and Adaptation Programme*
- *Back to Lab Programme for Women*

PROMOTIONAL PROGRAMMES

- *Kerala Science Congress*
- *Vocational skill oriented reinstated training*
- *Tech Fest, Green Corps, Eco Clubs*
- *Sasthraposhini & Sasthra Bhodhini*
- *SPYTIS Project for School and College Students*
- *Patent Information Centre*
- *Scientific Management Training*
- *Rural innovators Meet*

POPULARISATION PROGRAMMES

- *Science Popularization Programmes*
- *Support for Seminar, Symposia and Workshop*
- *National Science Day, National Technology Day, World Environmental Day, Ozone Day etc.*

Report of the Programme

A nurture workshop on 'Introduction to Astronomy' for B.Sc students were conducted on 22,23 September 2018 at Sullamussalam science College, Areekode. This workshop was a series of three workshops that have planned to organise during this academic year, as part of initiatives to prepare young generation to be effective participants of the emerging knowledge society and nurture a spirit of Innovation in them. The primary goal of this workshop was to introduce the fundamentals and recent advances in Astronomy. The recent developments in Astronomy was stimulated by both powerful ideas in theoretical physics and powerful instruments developed through physics.

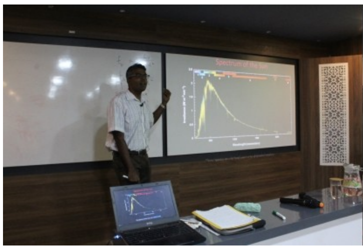
Day 1 – 24/09/2018 (Monday)

All the delegates registered for the workshop before 9.30 am on 24, September-2018 .The program was inaugurated by Dr. PP Abdul Haque, former Principal of Sullamussalam science college , Areekode. Head of the Department of physics , Mr CA Safeeque and convenor of the workshop Abdul Rahoof. K.A welcomed the chief resource persons Dr. Anand Narayanan and Mr. Sarath Prabhav to the workshop. Also all the participants and delegates were warmly welcomed. Ms. Fathima Sherin introduced the chief resource persons.

Dr. PP Abdul Haque, founder principal is inaugurating the programme

The first session 'Star as a black body' was then started by Dr. Anand Narayanan. The session was handled by Dr. Anand Narayanan. Write from the very fundamentals of Astro-Physics, the session stated. Scientific terms like luminosity, flux etc was introduced very keenly to the students. The electromagnetic spectrum of the sun was showed in presentation were it was a perfect example for Black Body in which the body was in thermodynamic equilibrium.

Desmos – web resource was introduced as a tool of plotting graph which had significance both in physics as well as astrophysics. The students had hands on experience on plotting a variety of graphs on board with the instructor. Also a variety of problems which tested both the mental and numerical aptitude of the students were given by the master. The significance of Statistical mechanics was showed through Maxwell Boltzmann distribution. It was taught how all the quantities V_{rms}, $\langle V \rangle$ and V_p were different .Then it was proved that Kinetic Energy of particle $\langle E \rangle_{radiation}$. Also, it was shown how the sun itself is a perfect example of black body and all the other stars behaved in the same manner.



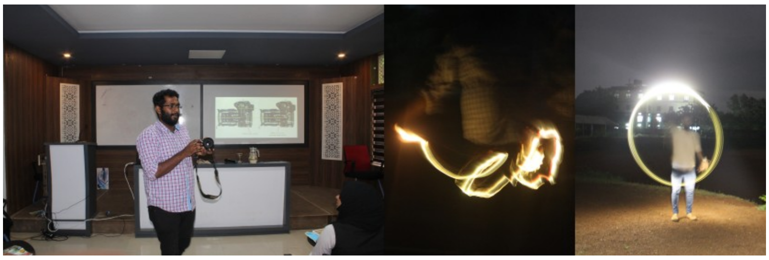

The session continued with General Astronomy talks by showing how the globe appears to a chemist as well as to a biologist. To Chemist it was the periodic table and to biologist it was all the species which is present in the earth. Dr. Anand Narayanan then put forward three provoking thoughts.

- Universe is also within us.
- We may be neither unique or alone in the universe.
- We live in a very vast universe.

The evening session was about Astrophotography. This session was handled by Mr. Sarath Prabhav. It was very interactive and captured the attention of the whole students as well as teachers. The topic was introduced right from the very beginning i.e, by defining the basis of photography like ISO, Aperture, Shuttering speed etc. And then onto Night Photography which is chief in Astrophotography. He practically pictured how to capture a perfect photography of stars, Nebulae, Moon, Galaxy and so on.

After refreshment , the CLUSTER was divided into seven and each of them was facilitated by a DSLR camera with a tripod stand. Also each group had an instructor too. All the participants were provided an opportunity of taking night photograph with the camera. But unfortunately, the climate was not that apt for night photography or sky watch because of the rain bearing clouds and moon. But to surprise, a hallo was formed on the moon which was observed very beautifully.

Application for mobile Photography like Camera 2 api brobe, Manual camera , proshot etc, were introduced by the instructor, Sarath Prabhav. This mobile applications had parameters like ISO , aperture, pixel and all that features required for night photography. Stellarium is another application which was used for capturing the beautiful image of constellation was also taught.



<u>Day 2 – 25/09/2018 (Tuesday)</u>

The second day's sessions was started by 9:30 am. The topic 'star formation and stellar evolution' was handled by Dr. Anand Narayanan in three sessions. In this lectures Stellar - Nucleosynthesis was discussed .It was taught how p-p reaction took place. Then the Shell Burning Structure was studied. Nuclear binding energy curve was studied very effectively. During his lectures he tried to do some problems and encouraged students to discuss and present their approach towards such problems.

The afternoon session was about 'New frontier in modern astronomy and career in astronomy' handled by Dr. Anand Narayanan. He introduced the students about the various career opportunity in astrophysics, also the different competitive examinations as a selection to the national institutes.

In the evening conducted a night photography discussion, handled by Mr. Sarath Prabhav. He analysed the photos taken by the students last night. In this session , fits was introduced for false colouring of Astrophotography.

Day 3 – 26/09/2018 (Wednesday)

The third day, the session began at 9.30 with paper presentations. This gave an opportunity for students to share their views and knowledge on Astrophysics. Master. Mr. Abhishek of MES College, ponnani presented paper on Gravitational waves, Mr. Jabir VM of MES College, presented paper on Dark matter and Dark energy, Ms. Swafvana Mehboob Koonmathodika of B.Sc. Physics first semester from Sullamussalam Science College, Areekode presented paper on ′ The interstellar medium', Ms. Bhavya of First semester B.Sc. Physics from Sullamussalam Science College, Areekode, presented a paper on ' What is gravitational lensing?'. Mr. Basim. M.B, Assistant Professor of PSMO College, Tirurangadi chaired the session.

After the paper presentation session conducted two tutorial sessions handled by Mr. Muhammmed Abdurahiman, Assistant Professor of MES College, Ponnani and Mr. Muhammed Shafi Ollakkan, Assistant Professor of PSMO College, Tirurangadi.

The final session was feed back and certificate distribution in which the different participants and teachers shared their experience on the three day nurture workshop and certificates were distributed to all the participants by the resource persons.

The programme was concluded by 4:30 pm.

Photos


Periodic Table of the Elements
INTRODUCTION TO ASTRONOMY
GTR-1916