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Mathematical Foundations of Processing the Results of Astronomical Scientific Observation and a Program Used In PHOTOMETRY

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Abstract:

The Earth is a space of dust on the astronomical scale; astronomy contains the physics of several stellar objects. These objects are very far away from Earth; moreover, they are the most interested and attractive objects for human beings. Human beings are continuously developing and installing the observational facilities (telescopes) for solving the mystery of the Universe. The various photometric bands/filters are associated with these telescopes, and each band show different effective wavelength to detect the information about the interior physical phenomenon. The detected information can be used to constrain the dynamism and evolution model of interested stellar objects. Heavier atoms of matter are to be made in the interior part of stars and prescribed matter to pervade into space through the "Supernova burst". Our earth is also made of such type materials. Thus, every molecule of our bodies is contained the matter that once was subjected to the tremendous temperatures and pressures at the center of a star.

Keywords: wavelength to detect the information, blood, required oxygen of our breath

1. INTRODUCTION

As a result, the iron in our blood, required oxygen of our breath, carbon, nitrogen, etc. of our tissues and calcium in our bones was formed through the fusion of smaller atoms at the center of a star. There are the several theories for explaining the formation of the planets, stars and other astronomical objects. These theories are guide to us for understanding the truth of formation of the Universe, but these are not truth itself. Consequently, these said theories are continuously revised and to keep leading us in the right direction. The astrophysics is a deeper understanding of the Universe and the information about the evolution of the Universe is continually increased through the analysis of new collected data. Moreover, this information is further leading the new concepts/models for describing the our present Universe and its future. Other words, the astrophysics are a scientific branch to understand the formation of planets, stars, pulsars, galaxies etc. and their associated physical phenomenon. The revolutionary changes has been occurring in the literature of astrophysical study due to the incorporation of new technology and algorithms.

In the 19th and 20th centuries, the astronomical studies had been carried out through the photoelectric and photographic data. The astronomical data had been collected through the various ground based observatories and space missions. The seeing conditions are highly influenced these observations, which leads the resolution and image quality of the instrument. Since, the accurate analysis is highly dependent on the quality of the data, therefore the ground based observations are performed at the time of stable weather conditions and cloud free sky. Recently, the photometric study of astronomical objects is carried out through the charged-couple-device (CCD) camera.

The image can be displayed almost immediately after the end of the exposure, and image processing can be used to enhance it. However, the detector area is much smaller than a photographic plate or film, which can be of any size required and provides much finer resolution. In the year 1975, the Scientists from the Jet Propulsion Laboratory were imaged first astronomical CCD image of the planet Uranus at a wavelength of 8900 Å (Janesick & Blouke, 1987). The CCD is made by a solid-state electronic component, which is a small rectangular piece of silicon wafer. This wafer is an array of individual light sensitive tiny picture element and said element is defined as a pixel. The said CCD cameras are containing their special and sensitive characteristics such as low noise fro long exposure time, large quantum efficiency, linearity, extended spectral sensitivity, image processing possibilities, real time aspect etc.

In the present day CCDs generally come in sizes ranging from 512 by 512 ¢picture elements¢ or pixels to arrays as large as 8192 by 8192 pixels (Howell, 2006). The read-noise and gain are the main characteristics of these CCDs cameras. Noise is arisen due to the collection of electrons and the transfer of charge packets. During the collection of electrons, noise stems fromthermal processes, light pollution and the generation of electron-hole pairs in the depletion region (Burt, 1974; Kristian et al., 1982; Weisner & David, 1992). To minimize the effect of thermal noise, CCD is cooled to very low temperatures, which are typically around 150-160 K (Kristian et al., 1982). In this low temperature, the work function of CCD is known as the slow scan mode, which permits long exposures of up to several hours (Weisner & David, 1992). Similarly, the heater and artificial light sources must be closed at the time of the observations of astronomical objects, which is further needed to reduce the thermal noise.

1.2. Working operation of CCD

CCD is based on the principal of photoelectric effect and also performs four tasks to generate an image namely photoelectron generation, electron collection, charge transfer and analog to digital read out. The each pixel of CCD array is a tiny detector for the photons of incident light. The incident photons hit the pixel region of silicon chip and these photons are absorbed by the electrons of the hitting area. These electrons are excited and freely move towards to the conduction band due to the extra absorbed energy of the photon compare to work function of metal surface. The photons having energy 1.1 to 4 eV generate single electron-hole pairs, whereas those of higher energy produce multiple pairs. Each individual pixel is collect the photons and store the produced electrons by these photons. These said electrons can be read out from the CCD array to a computer, which lead to produce a digital image of varying intensities of light detected by the CCD. In this connection, the electrons build up in the wells (pixels) over the period of its exposure to light (the integration) due the contact of incident photons with the CCD surface. A digital image is built up consisting of the pattern of electrical charge (intensity) present in each pixel. At the end of integration period, the incident light does not reach the CCD detector and the accumulated charge in each pixel is transferred to the on-chip amplifier, pixel by pixel. During the read out process, charge from the array must be moved out of the imaging region to a location where the amount of charge can be measured. The information from the rows of pixels is move down to a single parallel row (the serial register) which is read out sequentially by Analog-to-Digital (A/D) converter where it is measured and then recorded. The said collected charge of each pixel is measured

in the form of voltage. This voltage is converted into digital number by A/D converter. The prescribed measuring device is emptied and once again the process is repeated. This process continues until all of the pixels have been measured (read out).
On this background, an electronic map of the optical image which matches with the photons of the CCD saw is recreated at the computer.
Observational astronomy is a division of astronomy that is concerned with recording data about the observable universe, in contrast with theoretical astronomy, which is mainly concerned with calculating the measurable implications of physical models. It is the practice and study of observing celestial objects with the use of telescopes and other astronomical instruments.
As a science, the study of astronomy is somewhat hindered in that direct experiments with the properties of the distant universe are not possible. However, this is partly compensated by the fact that astronomers have a vast number of visible examples of stellar phenomena that can be examined. This allows for observational data to be plotted on graphs, and general trends recorded. Nearby examples of specific phenomena, such as variable stars, can then be used to infer the behavior of more distant representatives. Those distant yardsticks can then be employed to measure other phenomena in that neighborhood, including the distance to a galaxy.
Galileo Galilei turned a telescope to the heavens and recorded what he saw. Since that time, observational astronomy has made steady advances with each improvement in telescope technology.
Subdivisions
The Crab Nebula as seen in various wavelengths
A traditional division of observational astronomy is based on the region of the electromagnetic spectrum observed:
Radio astronomy detects radiation of millimetre to decametre wavelength. The receivers are similar to those used in radio broadcast transmission but much more sensitive. See also Radio telescopes.

Infrared astronomy deals with the detection and analysis of infrared radiation (this typically refers to wavelengths longer than the detection limit of silicon solid-state detectors, about 1 μm wavelength). The most common tool is the reflecting telescope, but with a detector sensitive to infrared wavelengths. Space telescopes are used at certain wavelengths where the atmosphere is opaque, or to eliminate noise (thermal radiation from the atmosphere).

Optical astronomy is the part of astronomy that uses optical instruments (mirrors, lenses, and solid-state detectors) to observe light from near-infrared to near-ultraviolet wavelengths. Visible-light astronomy, using wavelengths detectable with the human eyes (about 400–700 nm), falls in the middle of this spectrum.

High-energy astronomy includes X-ray astronomy, gamma-ray astronomy, and extreme UV astronomy.

Occultation astronomy is the observation of the instant one celestial object occults or eclipses another. Multi-chord asteroid occultation observations measure the profile of the asteroid to the kilometre level.

addition to using electromagnetic radiation, modern astrophysicists can also make observations using neutrinos, cosmic rays or gravitational waves. Observing a source using multiple methods is known as multi-messenger astronomy.

Ultra HD photography taken at La Silla Observatory.

Optical and radio astronomy can be performed with ground-based observatories, because the atmosphere is relatively transparent at the wavelengths being detected.

Observatories are usually located at high altitudes so as to minimise the absorption and distortion caused by the Earth's atmosphere. Some wavelengths of infrared light are heavily absorbed by water vapor, so many infrared observatories are located in dry places at high altitude, or in space.

The atmosphere is opaque at the wavelengths used by X-ray astronomy, gamma-ray astronomy, UV astronomy and (except for a few wavelength "windows") far infrared astronomy, so observations must be carried out mostly from balloons or space observatories. Powerful gamma rays can, however be detected by the large air showers they produce, and the study of cosmic rays is a rapidly expanding branch of astronomy.

Important factors

For much of the history of observational astronomy, almost all observation was performed in the visual spectrum with optical telescopes. While the Earth's atmosphere is relatively transparent in this portion of the electromagnetic spectrum, most telescope work is still dependent on seeing conditions and air transparency, and is generally restricted to the night time. The seeing conditions depend on the turbulence and thermal variations in the air. Locations that are frequently cloudy or suffer from atmospheric turbulence limit the resolution of observations. Likewise the presence of the full Moon can brighten up the sky with scattered light, hindering observation of faint objects.

For observation purposes, the optimal location for an optical telescope is undoubtedly in outer space. There the telescope can make observations without being affected by the atmosphere. However, at present it remains costly to lift telescopes into orbit. Thus the next best locations are certain mountain peaks that have a high number of cloudless days and generally possess good atmospheric conditions (with good seeing conditions). The peaks of the islands of Mauna Kea, Hawaii and La Palma possess these properties, as to a lesser extent do inland sites such as Llano de Chajnantor, Paranal, Cerro Tololo and La Silla in Chile. These observatory locations have attracted an assemblage of powerful telescopes, totalling many billion US dollars of investment.

The darkness of the night sky is an important factor in optical astronomy. With the size of cities and human populated areas ever expanding, the amount of artificial light at night has also increased. These artificial lights produce a diffuse background illumination that makes observation of faint astronomical features very difficult without special filters. In a few locations such as the state of Arizona and in the United Kingdom, this has led to campaigns for the reduction of light pollution. The use of hoods around street lights not only improves the amount of light directed toward the ground, but also helps reduce the light directed toward the sky.

Atmospheric effects (astronomical seeing) can severely hinder the resolution of a telescope. Without some means of correcting for the blurring effect of the shifting atmosphere, telescopes larger than about 15–20 cm in aperture can not achieve their theoretical resolution at visible wavelengths. As a result, the primary benefit of using very large telescopes has been the improved light-gathering capability, allowing very faint magnitudes to be observed. However the resolution handicap has begun to be overcome by adaptive optics, speckle imaging and interferometric imaging, as well as the use of space telescopes.

Measuring results

Astronomers have a number of observational tools that they can use to make measurements of the heavens. For objects that are relatively close to the Sun and Earth, direct and very precise position measurements can be made against a more distant (and thereby nearly stationary) background. Early observations of this nature were used to develop very precise orbital models of the various planets, and to determine their respective masses and gravitational perturbations. Such measurements led to the discovery of the planets Uranus, Neptune, and (indirectly) Pluto. They also resulted in an erroneous assumption of a fictional planet Vulcan within the orbit of Mercury (but the explanation of the precession of Mercury's orbit by Einstein is considered one of the triumphs of his general relativity theory).

Developments and diversity

ALMA is the world's most powerful telescope for studying the Universe at submillimeter and millimeter wavelengths.

In addition to examination of the universe in the optical spectrum, astronomers have increasingly been able to acquire information in other portions of the electromagnetic spectrum. The earliest such non-optical measurements were made of the thermal properties of the Sun. Instruments employed during a solar eclipse could be used to measure the radiation from the corona.

Fully-steerable radio telescope in Green Bank, West Virginia.

Radio astronomy

With the discovery of radio waves, radio astronomy began to emerge as a new discipline in astronomy. The long wavelengths of radio waves required much larger collecting dishes in order to make images with good resolution, and later led to the development of the multi-dish interferometer for making high-resolution aperture synthesis radio images (or "radio maps"). The development of the microwave horn receiver led to the discovery of the microwave background radiation associated with the Big Bang.

Radio astronomy has continued to expand its capabilities, even using radio astronomy satellites to produce interferometers with baselines much larger than the size of the Earth. However, the ever-expanding use of the radio spectrum for other uses is gradually drowning out the faint radio signals from the stars. For this reason, in the future radio astronomy might be performed from shielded locations, such as the far side of the Moon.

Late 20th-century developments

The last part of the twentieth century saw rapid technological advances in astronomical instrumentation. Optical telescopes were growing ever larger, and employing adaptive optics to partly negate atmospheric blurring. New telescopes were launched into space, and began observing the universe in the infrared, ultraviolet, x-ray, and gamma ray parts of the electromagnetic spectrum, as well as observing cosmic rays. Interferometer arrays produced the first extremely high-resolution images using aperture synthesis at radio, infrared and optical wavelengths. Orbiting instruments such as the Hubble Space Telescope produced rapid advances in astronomical knowledge, acting as the workhorse for visible-light observations of faint objects. New space instruments under development are expected to directly observe planets around other stars, perhaps even some Earth-like worlds.

In addition to telescopes, astronomers have begun using other instruments to make observations.

Other instruments

Neutrino astronomy is the branch of astronomy that observes astronomical objects with neutrino detectors in special observatories, usually huge underground tanks. Nuclear reactions in stars and supernova explosions produce very large numbers of neutrinos, very few of which may be detected by a neutrino telescope. Neutrino astronomy is motivated by the possibility of observing processes that are inaccessible to optical telescopes, such as the Sun's core.

2. CONCLUSION

Gravitational wave detectors are being designed that may capture events such as collisions of massive objects such as neutron stars or black holes.

Robotic spacecraft are also being increasingly used to make highly detailed observations of planets within the Solar System, so that the field of planetary science now has significant cross-over with the disciplines of geology and meteorology.

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