INQUIRIES OF HEAVEN

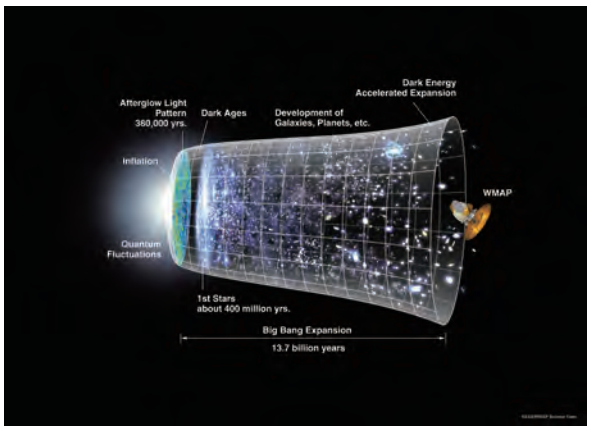
IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA, AUGUST 20 - 31, 2012 MONDAY, AUGUST 27, 2012 DAY 6

IAUS 289: Advancing the Physics of Cosmic Distances

Knowing the distance of an astrophysical object is key to understanding it: without an accurate distance we do not know how bright it is, how large it is, or even when it existed. But astronomical distance measurement is a challenging task: the only information we have about any object beyond our Solar System is its position (perhaps as a function of time) and its brightness (as a function of wavelength and time).

In 1997, the Hipparcos space mission provided – for the first time – a significant number of absolute trigonometric parallaxes at milliarcsec-level precision across the whole sky, which had a major impact on all fields of astrophysics. In addition, during the past ten years, ground-based 8–10m-class optical and near-infrared telescopes and space observatories have provided an unprecedented wealth of accurate photometric and spectroscopic data for stars and galaxies in the local Universe. Interferometric radio observations have achieved 10 micro-arsecond astrometric accuracy. Moreover, stellar models and numerical simulations are now providing accurate predictions of a broad range of physical phenomena, which can in principle be tested using accurate spectroscopic and astrometric observations.

Symposium 289 will highlight the tremendous amount of recent and continuing research



Different scales of the Universe at different stages of history.

into a myriad of exciting and promising aspects of accurately pinning down the cosmic distance scale. Putting the many recent results and new developments into the broader context of the physics driving cosmic distance determination is the next logical step. This will benefit from the combined efforts of theorists, observers and modellers working on a large variety of spatial scales and contributing a wide range of expertise.

This is a very exciting time in the context of this Symposium: VLBI (very long baseline interferometry) sensitivity is being expanded allowing, for example, direct measurement of distances throughout the Milky Way and to Local Group galaxies. The field will benefit from expert input to move forward into the era of Gaia-, optical-interferometer- and Extremely Large Telescope-driven science, which (for example) will allow us to determine Coma-cluster distances without having to rely on secondary distance indicators, thus finally making the leap to accurate distance measurements well beyond the Local Group of galaxies.

On our journey from the solar neighbourhood to the edge of the Universe, we shall encounter stars of all types, alone, in pairs and in clusters, their life cycles, and their explosive ends; the stellar content, dynamics, and evolution of galaxies and groups of galaxies; the gravitational bending of starlight; and the expansion, geometry and history of the Universe. As a result, the Symposium will offer not only a comprehensive study of distance measurement, but a tour of many recent and exciting advances in astrophysics. We aim to provide a roadmap for future efforts in this field, both theoretically and observationally. We therefore particularly encourage you to attend the Symposium's introductory plenary lecture by Wendy Freedman (Monday 27 August at 08:30). ■

Richard de Grijs

Associate Director and Professor at the Kavli Institute for Astronomy and Astrophysics at Peking University.

Giuseppe Bono

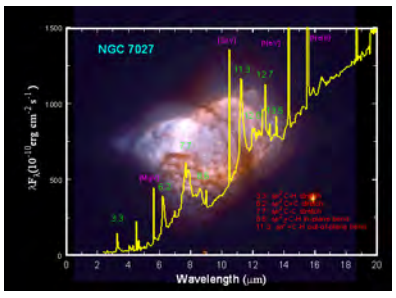
Associate Professor of stellar astrophysics at the Department of Physics at the University of Rome Tor Vergata.

SpS16: Unexplained Spectral Phenomena in the Interstellar Medium

There are several outstanding mysteries in interstellar medium spectroscopy which have remained unsolved after decades of effort. The diffuse interstellar bands (DIBs) have been known for almost a century. Although more than 400 bands from the near UV to near infrared have been detected, none of them have been identified. In the Milky Way Galaxy, DIBs have been seen towards over one hundred stars. DIB carriers in the interstellar medium of external galaxies can be probed by supernovae, and have been detected in galaxies with redshifts up to 0.5.

The 217.5 nm extinction feature has been known for about 45 years. It was extensively observed by the IUE and is found to have remarkable constancy in its peak wavelength of 217.5 nm. This is not just a local phenomenon as the feature has been detected in galaxies as distant as z>2.

A family of unidentified infrared emission (UIE) features was discovered over 30 years ago and the number of features has been expanding as the result of infrared spectroscopic observations from ISO and Spitzer. The UIE phenomenon includes aromatic bands at 3.3, 6.2, 7.7, 8.6, and 11.3 μm, aliphatic features at 3.4 and 6.9 μm, broad emission plateaus at 8, 12, and 17 μm, as well as a host of weaker features that are too broad to be atomic or molecular lines. Although the



A number of unidentified infrared emission bands can be seen in this ISO spectrum of the planetary nebula NGC 7027. The background image is an HST image of the object.

UIE phenomena have been widely attributed to polycyclic aromatic hydrocarbon molecules, other forms of carbonaceous materials have also been discussed.

The observation of the Extended Red Emission (ERE) also goes back 30 years. ERE is commonly seen in reflection nebulae but has also been detected in dark nebulae, cirrus clouds, planetary nebulae, HII regions, the diffuse interstellar medium, and in haloes of galaxies. Other than the fact that it is likely due to photoluminescence, the exact nature of its carrier is still unknown.

The 21 and 30 μm unidentified infrared features are generally associated with objects in the late stages of stellar evolution. Candidates that have been suggested include hydrogenated fullerenes, nanodiamonds, titanium carbide nanoclusters and a thiourea functional group associated with aromatic/aliphatic structures.

It is interesting to note that these phenomena have been observed not only in the ISM, but also in circumstellar environments, in the galactic halo, and in external galaxies. In some cases they have been observed in galaxies with redshifts > 2 suggesting that the carriers responsible for these features were already present in the early Universe. Due to the ubiquitous nature of these spectral phenomena, their carriers must be substances made of common elements, most likely carbon. There is an increasing consensus that the carriers are organic compounds unfamiliar to us in the terrestrial environment. The recent detections of C60 and C70 in planetary nebulae and reflection nebulae have also raised interest in other carbon allotropes in the ISM. In this Special Session, we bring together observers and laboratory spectroscopists with the goal to gain a better understanding of the origins of these long standing mysteries. ■

Sun Kwok

Chair Professor of Physics at the University of Hong Kong. He currently serves as the Vice President of Division VI (interstellar Matter) of the IAU, and is the incoming Vice President of IAU Commission 51 Bio-astronomy.