Astronomy and astronautics talk titles

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Contents

Talk titles with summaries

Introduction

All talks are illustrated with images, maps, diagrams and charts as appropriate. Some talks also include videos and animations. A list of references and bibliography is also provided following the talk for those who wish to pursue the subject further.

Talks are reviewed and updated on regular basis, usually before each presentation, especially for subjects with content that is liable to change with time, e.g. planned and current space missions. The summaries below reflect the content of the talks at the time of writing, but the actual content may be revised to reflect developments in subject material or further research.

1. Astronomical history

1.1 Astronomy in the ancient world

Beginning with a brief summary of archaeoastronomy, this is an overview of the astronomers and astronomical knowledge in Ancient Egypt, Mesopotamia, Classical Greece and the Hellenistic World (including the Great Library at Alexandria). There are some great names along the way, including Ptolemy, Aristotle, Hipparchus, Eratosthenes, Pythagoras and Aristarchus.
(See also related talk title: *Astronomical instrumentation before the telescope*)

1.2 Astronomy in the medieval world

It is sometimes supposed that there was no astronomical activity in the Middle Ages, but during this time much of the foundations of modern astronomy were laid. An overview of astronomers and astronomical knowledge from the 5th Century to the publication of Copernicus' On the Revolutions of Heavenly Spheres (in 1543), the talk begins with a review of the transmission of the Hellenistic astronomy of Ptolemy. Subjects covered include astronomy in India and Arabia, Anglo-Saxon England and Spain, as well as in the universities of Paris, Oxford and Bologna. Technological and other developments also influenced astronomy, including developments in optics, clocks, printing, and voyages of exploration by Italian and other navigators.
(See also related talk title: *Astronomical instrumentation before the telescope*)

1.3 Astronomical instrumentation before the telescope

There were many astronomical instruments before the introduction of the astronomical telescope. After a brief historical introduction, some instruments and their uses are described, as follows:

- Observational/measuring instruments, including Ptolemy's Rules, Jacob's Staff, Quadrant;
- Instruments representing the sky, including armillary sphere, astrolabe;
- Measuring time, including sundials and clocks.

1.4 Astronomy and music: From Pythagoras to Pink Floyd

The talk traces the following interweaved themes:

- The origin and development of the concept of the Harmony of the Spheres from Pythagoras, through Plato, Cicero, Boethius (among others) to Kepler and Newton
- Music inspired by astronomy, astronomers or space missions in a broad sense, e.g. Henryk Gorecki Symphony No. 2 Copernican, Vangelis and the Rosetta Mission
- Astronomers who were or are composers and/or musicians, e.g. William Herschel

- Music used for astronomical and space-related purposes, including television programmes and films, e.g. David Bowie and an International Space Station video

1.5 Astronomy and Exploration

Following an introductory section on astronomy and navigation, the talk covers astronomical aspects in navigation. Subjects covered include the Royal Observatory Greenwich and the Nautical Almanac, longitude and the development of the sextant and marine chronometer. The talk also covers some historical examples related to the history of astronomy in exploration, including Pytheas, Magellan and Christopher Columbus. There is a particular focus on British astronomers and explorers associated with observations of the Venus transits of 1761 and 1769 (including Jeremiah Dixon, Charles Mason, Capt James Cook, Charles Green, William Wales).
(*A related talk about astronomy in colonial North America is in preparation*).

1.6 Bryan Donkin FRS: Engineer, Industrialist, Astronomer

Beginning with a brief outline of the life and work of Bryan Donkin FRS, the presentation then focuses on aspects of Donkin's life and work of particular astronomical relevance. Donkin was active with many professional and learned societies, including the Royal Astronomical Society during its early years. Bryan Donkin and his company also manufactured scientific and astronomical instrumentation, including manufacture of equipment for the Royal Observatory Greenwich often in association with instrument makers Troughton and Simms. Other aspects that are covered include Donkin's astronomical observatory and his activities as an amateur astronomer.

1.7 Astronomy from the Great War to the Cold War

An overview of the history of astronomy and the development of astronautics from the First World War to the end of Second World War, subjects covered include:

- The First World War and the interwar years (1914 – 1939), including astronomy in exile: Albert Einstein and others
- The Second World War, including effects of wartime duties and restrictions, the blitz and the blackout, effects of military occupation and internment of enemy aliens
- Wartime origins of post-war developments in astronomy and astronautics, including radar and the origin of radio astronomy, British rocketry, and the growth of amateur astronomical societies.

1.8 William Rutter Dawes and Buckinghamshire Astronomy

Beginning with a summary of the life of William Rutter Dawes, the talk covers his involvement in astronomy including his observatories and his role in learned societies. There is a particular emphasis on his time in Buckinghamshire, including some of his early years and especially his later years at Hopefield House, Haddenham where he built an observatory, equipped with Clark and Cooke telescopes. There is a brief review of Dawes in the context of Buckinghamshire astronomy of the time, including the Herschel family and the Hartwell Synod of Dr John Lee and his associates.

1.9 The Hartwell Synod: Admiral Smyth, Dr John Lee and their associates

The talk covers the astronomical interests of Dr John Lee and Admiral William Henry Smyth, Dr Lee's observatory at Hartwell House, the assistants of Dr Lee (including James Epps, John Glaisher and Norman Robert Pogson), and various contemporaries in Aylesbury and nearby villages including William Rutter Dawes (Haddenham), Thomas Dell (Aylesbury), Rev William Fletcher (Stone), William Stephen Jacob (Stone), Rev Charles Lowndes (Hartwell),

Rev Joseph Bancroft Reade (Stone) and Joseph Turnbull (Aylesbury). This updated version includes improved figures and maps, as well as photographs by the speaker taken in May 2017, including of the inconclusive search for signs of the former observatory at Hartwell House.

1.10 Some aspects of Lincolnshire astronomy

The astronomical and related contributions of selected individuals through history with Lincolnshire connections are summarised, including Henry Andrews; Sir Joseph Banks; George Boole; Rev Canon John Cross, Edward Iszatt Essam, Capt Matthew Flinders; Sir John Franklin; Robert Grosseteste, Bishop of Lincoln; Sir Thomas Little Heath; James William Jeans; Sir Isaac Newton; Rev Dr William Pearson; Francis Cranmer Penrose; Dr William Stukeley; Alfred Lord Tennyson and Colonel George Tomline. The emergence of scientific and astronomical societies, from the C18th antiquarian societies, especially the Spalding Gentlemen's Society, through the C19th mechanics institutes and finally the astronomical societies in the C20th is also outlined. Lincolnshire observatories past and present are summarised.

1.11 Some aspects of Norfolk Astronomy

The astronomical and related contributions of selected individuals through history with Norfolk connections are summarised, including Thomas Baines; James Garton Bower; Sir Edward Crisp Bullard; Thomas Catton; William Cunningham; Albert Einstein; Brigg Fountaine; Thomas Hawkes; Roger Long; Nicolas Lynn; Robert James Mann; Charles Walter Munday; Algernon Montague and George James Newbegin; Arthur P Norton; Gilbert E Satterthwaite; Capt George Vancouver. In addition, the history of astronomical societies and of observatories past and present is outlined.

2. General astronomy

2.1 Infrared astronomy

Discovered by Sir William Herschel in 1800, Infrared radiation has in recent years become important in astronomical research and observational techniques. Beginning with an introduction to visible light and the electromagnetic spectrum, the talk covers concepts including wavelength and frequency, and infrared radiation and spectra. A brief review of the IR sky and astronomical sources of infrared is followed by consideration of the advantages and disadvantages of IR astronomy, and problems from atmospheric absorption of infrared radiation. There is a brief review of terrestrial IR astronomy, including ground-based observatories (e.g. UKIRT) and aircraft (e.g. SOFIA) as well as IR astronomy surveys. Much IR astronomy is conducted from space and some satellites and observatories (e.g. Spitzer Space Telescope, Herschel) are reviewed together with IR instruments on selected space probes (e.g. Venus Express, Cassini, New Horizons). Finally, there is a summary the future of IR astronomy studies and space observatories.

2.2 Microwave astronomy

Radio and microwave astronomy opened up new areas in astronomical and cosmological research and has led to highly significant discoveries. Beginning with an introduction to visible light and the electromagnetic spectrum, the talk covers concepts including wavelength and frequency, and microwave radiation and spectra, as well as a summary of the principal areas of study in microwave radio astronomy. There is a brief historical survey with a summary the origins of microwave and radio astronomy through the work of radio and radar pioneers and the early discoveries to the rapid growth in radio astronomy after World War

Two. There is a brief survey of techniques and facilities in radio astronomy (e.g. Jodrell Bank) and the related transitional areas of millimetre wave astronomy (e.g. ALMA) and submillimetre wave astronomy (e.g. James Clerk Maxwell Telescope). The relevance of microwave astronomy to concepts in cosmology is outlined, including the debate about the Big Bang or Steady State, with the eventual discovery of the cosmic microwave background radiation and subsequent launch of satellites (e.g. COBE, Planck) to study it further. Microwave astronomy is also relevant in other areas including interstellar chemistry and the search for extraterrestrial intelligence (SETI).

2.3 Astronomers' Guide to the Chemical Elements

The origin of the chemical elements is very much within the area astronomy, although the chemical elements are the fundamental building blocks of chemistry. Beginning with an historical survey, the talk includes the concept of element from ancient times to Lavoisier, the growth in the discovery of chemical elements especially since the C18th, Dalton and atomic theory, Thomson, Rutherford and Chadwick and atomic structure, Mendeleev and the periodic table of the elements and cosmic elemental abundances. The talk covers particular cosmic events and astrophysical processes that are associated with the origin of the chemical elements. The Big Bang was the source of hydrogen, helium and traces of other light elements. Fusion processes in stars (nucleosynthesis) lead to the formation of helium and elements between carbon and iron. This section includes Lockyer and the discovery of helium, Hoyle and stellar nucleosynthesis, the life and death of a small star and nucleosynthesis in larger stars. The production of the heaviest naturally occurring elements occurs as a result of supernovae and there is a summary of types of supernovae and of explosive nucleosynthesis. Finally there is a summary of radioactivity, its discovery, types of radioactivity and radioactive decay, and the role of cosmic rays in the cosmic abundance the gap between helium and carbon.

3. Planetary sciences

3.1 Origin of the Solar System

The origin of the Solar System has long been a subject of interest for scientists and philosophers, including René Descartes (1644), Immanuel Kant (1755) and Pierre-Simon Laplace (1796). Beginning with an overview of areas of interest and methods of study on Earth and in space using probes and astronomical observatories, the models for the origin of the Solar System are covered, including the nebular theory. The origin of the Sun and other Solar System objects is summarised. The origin of the Earth-Moon system is covered, including the collision that is thought to have formed the Moon. There is a brief comparison of the objects in the inner Solar System as an introduction to comparative planetology. Finally, there is an outline of some exoplanetary systems, the discovery of which presents some challenges to the understanding of the origins of the Solar System.

3.2 Piecing together the Moon: Unlocking the secrets of the returned lunar sample

The returned lunar samples contributed greatly to our knowledge of the Moon and its origin. This illustrated talk covers sample collection and return as well as discoveries about the samples on Earth. Since Apollo the knowledge of the Moon has grown and use of lunar materials could be important in the future of space exploration and development.

3.3 Mars: Sixty years of space exploration

This talk is a review of Mars missions beginning with the first successful flyby of Mars by Mariner 4 in 1965, and historically significant as well as recent missions, including Viking, Mars Global Surveyor, Mars Odyssey, Mars Express, Mars Exploration Rovers, Mars Reconnaissance Orbiter, Curiosity, MAVEN and InSight. There is a brief overview of the future of Mars Exploration, including possible future human missions to Mars.

3.4 Exploration of Jupiter

Beginning with a general introduction to the outer planets and the gas giants as well as Jupiter's features and nomenclature, there is an historical survey of observations before the Space Age. The talk then covers the space missions, including Pioneer, Voyager, Ulysses; Galileo; New Horizons and Juno, as well as observations with the Hubble Space Telescope. There is also coverage of the impact of Comet Shoemaker-Levy 9, observations made and results obtained. There is a survey of Jupiter and its satellites, including a description of Jupiter's atmosphere, its internal structure, magnetosphere and radio emissions, the rings, the Jovian satellites and the origin of Jupiter and satellites. The atmosphere, structure and composition of Jupiter are also considered in relation to Saturn and outer giant planets more generally.

3.5 Exploration of Saturn

Beginning with a general introduction to the outer planets and the gas giants as well as Saturn's features and nomenclature, there is an historical survey of observations before the Space Age. The talk then covers the space missions, including Pioneer, Voyager and Cassini-Huygens, as well as observations with the Hubble Space Telescope. There is a survey of Saturn, including a description of Saturn's atmosphere, structure and composition. The rings and satellites are also considered, especially Titan and Enceladus in relation to astrobiology. The origin of Saturn and its satellites is also considered. The atmosphere, structure and composition of Saturn are also considered in relation to Jupiter and outer giant planets more generally.

3.6 Pluto and the outer solar system

Beginning with an overview of the discovery of Pluto and its demotion to the status of "dwarf planet", the talk then includes a brief description of the New Horizons spacecraft instrument packages and results received following the July 2015 flyby of Pluto and Charon and the flyby of Kuiper Belt Object Arrokoth (Ultima Thule; 2014 MU69) in January 2019. The extended missions of New Horizons are also covered. The final section covers the Edgeworth-Kuiper Belt, including the Plutinos, Plutoids and Cubewanos and the principal objects so far discovered including Eris, Haumea and Makemake, as well as the Oort-Opik Cloud and the boundary of the Solar System.

3.7 New Horizons at Pluto and beyond

Beginning with a summary of the discovery of Pluto, this illustrated talk with video and animations as well as still images, includes a description of the New Horizons spacecraft instrument packages and the results of the July 2015 flyby of Pluto and Charon and the flyby of Kuiper Belt Object Arrokoth (Ultima Thule; 2014 MU69) in January 2019. The extended missions of New Horizons, most recently for 2 years from 2022, are also covered.

4. Astrobiology

4.1 Astrobiology

Also known as bioastronomy and exobiology, astrobiology draws on many subjects. The talk reviews the astronomical and chemical requirements for life, ideas on the origin of life and an overview of ecology on Earth. Finally, the possibility is considered of life elsewhere in the Solar System and beyond. There is also coverage of the search of present and/or former extraterrestrial life, including the relevance of the recent Mars missions. Also considered are Europa and Titan, as well as recent exoplanet searches and discoveries. Finally, environmental and ethical aspects are covered.

4.2 Life on Mars?

Beginning with an historical survey, the talk covers the concept of plurality of worlds with specific reference to Mars, the *canali* from channels to canals, life on Mars and popular culture and the view before the space age of the possibility of life on Mars. There is an overview of Mars missions, many of which have contributed greatly to our knowledge of Mars and its past, as well as the search for life. The history of Mars is covered including environments past and present, the ages of Mars, its climate and seasons, and water and atmosphere. When considering the possibility of life on Mars, there might be some clues from life on Earth, in particular the origin of Life, archaea and life in extreme environments. Finally, there is a review of the search for life on Mars, including a review space missions, including the Viking biology experiments, the debate surrounding Martian meteorites and possible microfossils, as well as possible future missions and searches.

4.3 Search for extraterrestrial intelligence (SETI)

The possibility of extraterrestrial intelligent life has long been a subject of interest for scientists and philosophers. Beginning with the historical background and the famous Drake Equation, the talk considers the prospect for extraterrestrial intelligence, including astronomical and chemical requirements for life; biochemistry, ecology and Intelligence; and technology and civilization. The talk covers the search for extraterrestrial intelligence (SETI), including consideration of what we are looking for and possible detection methods. Some SETI projects are reviewed including Project Ozma in 1959, as well as more recent SETI projects, both radio and optical, including citizen science/pro-am collaborations. Possible communication with extraterrestrial intelligence (CETI) and the estimates of the number of extraterrestrial civilizations in the Galaxy led to the famous Fermi Paradox – if there are so many extraterrestrials then where is everybody? Possible explanations might arise in the area of bioethics and extraterrestrial life, through ideas such as the "zoo hypothesis".

5. Astronautics

5.1 The Apollo years

Especially relevant with the celebration in 2019 of the 50th anniversary of the landing of Apollo 11 on the Moon in July 1969, the talk outlines the race between the Americans and the Russians to the Moon. There is coverage of the early missions and the Apollo missions and spacecraft, with a review of the growth of our knowledge of the Moon as a consequence of the Apollo missions. The talk also covers Apollo after the Moon, including the Skylab space station and the Apollo-Soyuz Test Project. of the final section covers Artemis and the return to the Moon, including the Lunar Gateway.

5.2 Space Stations

Beginning with some of the early ideas for space stations, the talk then covers early (Skylab and Salyut) space station missions. After Salyut, Russian space station activity was based on Mir, which was also to play a role in the development of International Space Station (ISS) operations through the Shuttle-Mir missions. The talk also covers the development of the ISS from the original American Space Station Freedom concept. The development of the ISS configuration and also the role of British-born astronauts in Mir and ISS operations are also included. Finally, there is an overview of space station applications and the potential role of space stations in space exploration and development.

5.3 Europe in space

Beginning with the early European organizations European Launcher Development Organization (ELDO) and European Space Research Organization (ESRO), the talk then outlines the history of European Space Agency (ESA). There is an overview of unmanned European missions, including significant past legacy missions (e.g. Venus Express) and missions in the operations/post-operations phase (e.g. Cassini- Huygens, Gaia, Mars Express). There is also a review of planned missions in the implementation phase (e.g. Euclid, JUICE). European participation in human spaceflight is also covered, including European astronauts on the International Space Station (including Tim Peake's Principia mission), the Columbus ISS module and the Service Module for the Orion spacecraft.

5.4 Britain in space

Beginning with a survey of Britain's rocketry pioneers, the talk covers the formation and contributions of the British Interplanetary Society. British rockets include the Skylark, Black Arrow and Blue Streak. Although Britain launched only one satellite with its own launcher, Prospero in 1971, there was a British satellite programme including the Ariel satellites (1962 – 1971). Britain has also participated as an international partner in other missions, including the Netherlands/UK/USA Infrared Astronomical Satellite (IRAS) and also through membership of the European Space Agency (ESA). The British space industry participated in the construction of many satellites and spacecraft, both British and European. In addition, the University of Surrey built a series of small satellites. The roles of British astronauts on Mir (Helen Sharman and Project Juno) and International Space Station operations (Tim Peake and Principia) are also included, as well as a review of other British-born astronauts. Finally, there is a review of British plans for launch vehicles and spaceplanes including Reaction Engines and Skylon, and Starchaser Industries.

5.5 Lunar resources for space exploration and development

Construction of large-scale facilities in space or on the Moon will require large quantities of structural and other materials. It would not be practical to transport all the materials from the Earth. It is therefore necessary to investigate extraterrestrial sources of the materials from bodies with lower acceleration due to gravity compared to the Earth, such as the Moon or asteroids. This talk reviews potential lunar resources and the possible methods of extraction and processing in order to provide materials for the construction of space colonies. The terrestrial drivers and incentives for developing extraterrestrial resources are considered along with the possible effects of physical properties on extraterrestrial mining. The Moon and its potential resources, including water ice, ilmenite, oxygen and metals, and associated extraction processes, including chemical reduction, electrolytic techniques and biomining, are considered. Associated issues such as energy sources and storage, and the potential of other minerals and products, such as KREEP and Helium-3, and processes, such as solar photolysis are also examined.

5.6 Bioethics: An extraterrestrial perspective

A review of ethical and other related issues as applied to spaceflight, the space environment and the exploration of space, including the following: .

- human individuals (e.g. health and safety at work in space, satellite surveillance, space colonist selection)
- international relations (e.g. space programmes and the developing world)
- Earth environment (e.g. environmental impact of launch vehicles, space debris)
- cosmic environment (e.g. mining the Moon, "terraforming", astro-engineering)
- extraterrestrial life (e.g. planetary protection, Mars sample return, the Fermi Paradox)
- future of humanity (e.g. ethics of genetically engineering humans to colonize diverse extraterrestrial environments).

5.7 Interstellar spaceflight from precursor missions to breakthrough propulsion

This talk covers precursor interstellar mission concepts as well as propulsion methods that would require significant technological development and/or scientific breakthroughs, including targets and methods as follows

- the outer Solar System and beyond, e.g. electrostatic (ion engines) and plasma propulsion, solar sails and lightcraft, including recent and planned solar sail missions, Nuclear thermal (NTR), Nuclear electric;
- interstellar spaceflight, e.g. organizations involved, targets and challenges, propulsion based on fusion and antimatter, British Interplanetary Society Daedalus study project
- Longer term ideas which would require fundamental breakthroughs are also covered, including breakthrough propulsion physics (BPP) for interstellar spaceflight, e.g. starships using Alcubierre warp drive, worldships and interstellar migration and Einstein-Rosen bridges ("wormholes" and "stargates").

Appendices: General and supplementary information

A Format of talks and facilities required

All talks are available as PowerPoint presentations (pptx and ppt) but can also be presented in pdf format if necessary. However, in ppt and pdf some videos and animations might not run. For venue-hosted meetings, the presentations are usually brought to the meeting on a memory stick or CD. It is requested that a data projector and laptop with PowerPoint and up-to-date antivirus software are available. Please make it clear at the time of enquiry and booking if I am required to provide a laptop for the talk. Unfortunately, I do not have access to a data projector.
Some talks are also available for presentation by virtual means, usually on Zoom. However, at the present time I do not have my own Zoom account. For virtual talks only, there are no distance restrictions, nor no expenses required.

B Travel distance and expenses

These talks are available to astronomical societies and similar organizations in Birmingham, London, north Buckinghamshire and adjacent counties (Bedfordshire, Birmingham, Cambridgeshire, Hertfordshire, London, Northamptonshire, Oxfordshire and Warwickshire). Further information about the expenses charged is available on request and can be discussed at the time of enquiry and booking, but the following general principles apply

- **travel by train in one day**: if the return journey can be completed in one day, standard class day return[1] will apply. (This usually only applies mid-week for talks in the London area and along the West Coast Main Line.)
- **travel by train with overnight stopover**: if the return journey cannot be completed in one day, then standard class ordinary return[1] will apply and an offer of overnight accommodation will be required.
- **travel by car**: Expenses are calculated based on a mileage rate of 40p per mile. In addition, any supplementary charges for road or bridge tolls and ferry fares may also be charged. For journeys beyond a 50-mile radius of Milton Keynes (one-way), an offer of overnight accommodation is requested, though is not always necessary.

C Publicity information and articles

Brief details of each talk, suitable for use in press releases, on websites etc, are presented above. In addition, short articles based on these talks and suitable for inclusion in society magazines may be obtained from Dr Leggett. Such articles should be requested, with an indication of word limit, well in advance of the intended copy date.

[1] Or nearest equivalent rail ticket as available from the appropriate train operating company at that time.

D Speaker information and contact details

As a founder member of the South Lincolnshire Astronomical and Geophysical Society in 1976, Dr Mike Leggett began to present astronomy talks for his local society. Since that time he has presented lectures for the British Interplanetary Society, at University of Aberdeen evening classes, for the Society for the History of Astronomy and to astronomical societies and other groups throughout the UK. He is the General Secretary and a Council member of the Society for the History of Astronomy (SHA), and is currently county co-ordinator for Buckinghamshire, Lincolnshire, Norfolk and Rutland in the SHA survey of astronomical history of the UK.

A Fellow of the Royal Astronomical Society and a Fellow of the British Interplanetary Society, Dr Mike Leggett is also a member of the British Astronomical Association, the Society for Popular Astronomy, the National Space Society and the Planetary Society.

A Graduate in Chemistry and Pharmacology from the University of Nottingham, Dr Leggett also holds a PhD in Chemistry. A Chartered Chemist and a Member of the Royal Society of Chemistry, he is a member of the Astrophysical Chemistry Group. He also holds a Postgraduate Diploma in Technical Authorship and Communication and is Member of the Institute of Scientific and Technical Communicators.

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