Astronomy: an introduction to celestial science.

The course is designed to be an introduction to modern astronomy easily accessible to students with no significant prior experience of either mathematics or the physical sciences, yet also having interestingly non-trivial content for those with some such background. It is intended both to inspire and to enlighten**:** to inspire a purely aesthetic sense of the extraordinary visual beauty and sheer grandeur of the cosmos we are privileged to inhabit and, at the same time, to show how the application of the scientific method can make logical sense of that awesome creation. The tutor passionately believes that, far from being mutually exclusive, these two ways of appreciating the cosmos can work powerfully together, each complementing and motivating the other. This, fundamentally, is nature-study on the grandest scale.

There will be 14 classes devoted, respectively, to the topics listed below. The lectures will be very visual presentations making extensive use of the best and most instructive images from the world's great telescopes – as well occasionally, at a much humbler level, of the course-tutor's own astronomical drawings: it should not be thought that these things are wholly beyond the reach of the 'backyard astronomer'. To prove that last point, we will also incorporate as much real outdoor observing as weather and circumstances allow, both at Wroxton with small portable instruments and with larger telescopes at the Hanwell Castle observatory (www.hanwellobservatory.org.uk) a few miles away. Personal observation by class-members outside our formal sessions will also be encouraged for those wishing to pursue this further, and the tutor will provide specific suggestions for interesting possibilities. The constant aim will be to make the course a rich mix of fun and of serious engagement with rigorous, hard-headed science.

Weekly topics:

1) Introduction to astronomy. The view from here: the Earth in space, the revolving celestial sphere, the night sky and constellations, the Sun and seasons, Moon and planets.
2) Light and vision: observing the sky with unaided eye, with optical and other telescopes, the instrumental resources of modern astronomy.
3) The Solar System, an overview: planets, moons, asteroids and comets; 'on the revolutions', orbits, Copernicus, Kepler, Newton and the Sun's family as a dynamical system; comparison with other stars' planetary families.
4) More on our Moon: its relation to the Earth, and Earth-Moon dynamics; its spectacular scenery – how to visit another world from your own backyard; its peculiarities; the debate over its origin; its effects & possible influence on the Earth; unsolved puzzles of lunar science.
5) The other rocky planets, Mercury, Venus, Mars: similarities and differences both amongst themselves and with the Earth; how typical are biogenic worlds? – the search for life on Mars, our planet and the 'Rare Earth' hypothesis.
6) The bigger planets: the gas giants Jupiter and Saturn; the ice giants Uranus & Neptune; comparison with 'Hot Jupiters' orbiting other stars, a cautionary tale (one example doth not a statistical sample make); historical aside, William Herschel's magnificent obsession, William & sister Caroline – the greatest of all scientific partnerships?

7) Celestial mechanics: a non-mathematical introduction to classical gravitation and the dynamics of the celestial orbs, from Newton to the present day, from revolving planets to spiral galaxies and even clusters of galaxies.
8) Stars, an introduction to stellar astrophysics: our Sun as a typical star – or is it?; the diversity of other stars, giant, supergiant, dwarf, double *et al*; spectroscopy and the Hertzsprung-Russel diagram; temperatures, masses, compositions and energy-sources of stars.
9) Galactic astronomy: nebulae, the birth of stars, star-clusters, stars as furnaces of element-creation, supernovae, neutron stars and cosmic recycling – 'we are all stardust'.
10) Putting the third dimension into it all, or cosmic distances and how to determine them: terrestrial baselines and parallax within the Solar System, transits of Venus and the distance to the Sun; using Earth's orbit as baseline to reach the stars, from Bessel to *Gaia*; Cepheid variables, Type Ia supernovae and other 'standard candles' to plumb the extragalactic depths.
11) Beyond the Milky Way: other galaxies, spiral, elliptical, irregulars, colliding, the 'extragalactic zoo'; clusters of galaxies and clusters of clusters; the problem of 'missing mass' or dark matter.
12) Extreme celestial objects & events: white dwarfs, neutron stars and black holes, their nature and their role as energy sources; cataclysmic cosmic violence – white dwarfs and Type Ia supernovae, neutron stars and gamma-ray bursters, coalescence of binary black holes and gravitational-wave astronomy with *LIGO et al.*
13) Cosmology – serious science or intellectual presumption? – the rudiments: the Universe cannot be a static system even in Newtonian physics; the expanding Universe, the Big Bang and the initial singularity; is creation *ex nihilo* of the raw materials possible thanks to (and only to) gravity?; the creation of worlds and systems from those raw materials certainly the handiwork of gravity. Cosmic acceleration, dark energy and other unsolved problems.
14) This session held unassigned to any specific class-topic to allow latitude for inclusion of at least one full session devoted to practical telescopic, etc observing. This may be inserted in the schedule at any point other than session 1, as weather and clear skies allow. We will *hope* to include more than one such outdoor event, in fact, so some compression of the above program of class topics may be necessary but these practical sessions will themselves be focussed as closely as possible on the material to be covered in class.

For some classes, such as those for topics 2) and 8), the tutor will also provide relevant items of equipment for practical lecture-demonstrations.

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