University of Glasgow | School of Physics & Astronomy

Astronomy 1 [ASTRO1001]
Astronomy 1 half [ASTRO1002]

Course Information Guide 2022-23

1 Welcome from Head of School

As the Head of School of Physics and Astronomy, I would like to welcome you to your new class. The School prides itself in providing an excellent and supportive learning and teaching environment that is fully integrated with our research; you will have the opportunity to interact with world-leading researchers working at the cutting edge of a wide range of fields of physics and astronomy, who are tackling some of the biggest contemporary challenges in science and technology.

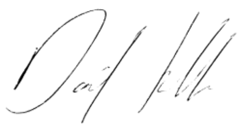
During the pandemic, our staff developed new ways of delivering high quality learning and teaching, and have been working to combine these with our traditional approaches. This is an ongoing process of development, and I ask that you engage with us through any of the available communication channels in letting us know what works and what does not.

One thing that will not change is the School’s firm commitment to supporting equally the careers and development of all its students and staff, as exemplified by our receipt of an Athena Swan Silver award. We value the diversity of our student body and recognise that this diversity improves the quality of our work by bringing a wide range of skills and viewpoints. We therefore expect that all staff and students will work productively and professionally together in an atmosphere of mutual respect.

To support this, all our staff and graduate students undertake equality and diversity training, our lab guides include a code of conduct for students, supplementing the University code[1], and we support the University's Dignity at Work and Study policy[2]. You can be assured that any instances of bullying, harassment, or offensive language or behaviour will be both taken seriously by the School and treated with sensitivity. Points of support for students are your adviser of studies, your Class Head and Lab Head, and in addition the School has two appointed Equality and Diversity offices, to whom students may speak in confidence.

I wish you success with your current and future studies.

Best wishes



Professor David Ireland
Head of School

[1] https://www.gla.ac.uk/myglasgow/senateoffice/studentcodes/studentconductstaff/
[2] https://www.gla.ac.uk/myglasgow/humanresources/equalitydiversity/dignityworkstudyover/

Contents

2 Fast Facts

2.1 Astronomy 1 (ASTRO1001)

Course title:	Astronomy 1.
Course credits:	40 credits.
Semesters taught:	Semesters 1 and 2.
Essential Prerequisites:	B in Maths at SQA Higher or equivalent. Pass in Physics at SQA Standard Grade or equivalent. (Pass in Physics at SQA Higher or equivalent is strongly advised).
Co-requisites:	Maths 1R/1S OR 1X/1Y and Physics 1 are strongly advised (and required for anyone wishing to pursue a degree in Astronomy).
Excluded courses:	Exploring the Cosmos 1X, Exploring the Cosmos 1Y.
Lectures:	Lectures are daily at 1000.
Laboratories:	Laboratories are on certain Mondays or Thursdays, 1330-1630. These are held at the University Observatory in Acre Road. Students attend two labs per semester.
Tutorials:	Students attend one large-class tutorial every fortnight. There are 5 tutorials every semester.
Assessment:	Degree examination: 2 papers in April/May = 55% Class Test: end of semester 1 = 20% Tutorial assignments = 10% Laboratory work = 15%
Degree examinations:	The degree examinations for Astronomy 1 are taken in April/May with resit opportunities in July/August.
Prizes:	A small number of prizes are reserved for the class and will be awarded to those students with the best record of work throughout the year.
Key Personnel: Class Head Deputy Class Head Lab Head Administration Technician	 Dr John Veitch (john.veitch@glasgow.ac.uk) Dr Iain Martin (iain.martin@glasgow.ac.uk) Dr Iain Martin (iain.martin@glasgow.ac.uk) Ms Ewa Bakowska (phas-teachingsupport@glasgow.ac.uk) Mr Colin Hunter (colin.hunter@glasgow.ac.uk)
Moodle site	http://moodle.gla.ac.uk/

2.2 Astronomy 1 half (ASTRO1002)

The 20-credit Astronomy 1 (half) course is available only in semester 1; it is designed as a mechanism for students who opt to leave the 40-credit full-year course mid academic year. ASTRO1002 is NOT available to visiting students.

Students should attempt all first semester labs and assignments as well as the end of first semester class test, with these assessments being weighted the same as for ASTRO1001. Students should also attempt the single 90 minute degree exam paper in April/May (co-located in space-time with the first paper taken by the ASTRO1001 class), with a resit opportunity in August. This sole paper is weighted at 55% of the assessment for ASTRO1002. All pre- and co-requisites stated for ASTRO1001 apply to ASTRO1002 as does the list of excluded courses.

3 Course Description

Astronomy 1 is an introductory class for students who want to study honours Astronomy as a combined degree, or for students who just wish to know more about planets, stars, and general astronomy. The treatment of the subject is quantitative, involving some mathematics and physics.

Astronomy 1 is taught from September through to March. The first semester course components concentrate on the solar system, while the second semester components focus on the wider universe: stars, galaxies and cosmology. The lecture course components are supplemented by class tutorials and there is also a laboratory component in each semester.

Astronomy 1 constitutes a prerequisite for taking Astronomy 2, and for proceeding to a combined honours degree in Astronomy.

3.1 Brief Overview of Teaching in Astronomy 1

3.1.1 Lectures and Lecture Notes

The class meets five days a week at **10:00** for lectures and tutorials. ***Come prepared to take notes at every lecture***. Essential are a supply of paper and at least one writing implement. The best arrangement is to use loose-leaf pre-punched paper, building up course notes topic by topic. This will also allow lecture hand-outs to be incorporated easily within the correct course element. Check the timetable to see what the next lecture is, and bring along the appropriate accumulated notes. It is good practice to read over lecture notes as soon as possible after the lecture has been delivered: this will help identify problems of understanding as they arise.

3.1.2 Tutorials and Assignments

Class tutorials are held at which tutorial questions are set and discussed. These tutorials will usually be held every second week on Tuesdays and Wednesdays at 10:00 instead of lectures on those days. You must attend the section that you are assigned to, unless you have medical or other extenuating circumstances, reported via MyCampus.

Tutorial sessions are vital to the course, providing a crucial opportunity for students to work with their peers, and question the tutors on aspects of the course. **Remember to bring all course notes with you to the tutorials.**

In addition, written assignments will be set; these must be submitted so that they can be marked and returned. The marks awarded for assignment work form an element of *continuous assessment*, and count towards your final mark in Astronomy 1.

Students should pay particular attention to the continuous assessment minimum requirements for award of credit (see below). Failure to meet these minimum requirements will normally result in no credit being awarded (i.e. a result of CR = ‘credit refused’) for Astronomy 1.

Marked assignments will be returned electronically via Moodle and should be read in conjunction with the marking schemes as these provide valuable feedback about your progress in Astronomy 1.

3.1.3 Laboratories

Each student should attend **2 laboratory sessions in Semester 1, and 2 in Semester 2**. These are held at the Acre Road Observatory on certain Monday and Thursday afternoons, unless otherwise stated (e.g. due to remote teaching). A separate handbook detailing the laboratory sessions will be issued to students before the start of the laboratory sessions. You are required to read in advance the appropriate lab script for each experiment and complete a pre-lab question on Moodle before the start of each laboratory session.

3.2 Examinations and Assessment

3.2.1 Breakdown of Assessment in Astronomy 1

Written degree examinations for Astronomy 1, consisting of two 90 minute papers, will be held at the end of the session (in April/May). Lecture material presented in semester 1 will be examined in the first paper lecture material presented in semester 2 will be examined in paper 2. Each paper will consist of three sections, each containing a choice of two questions worth 17 marks. Students should attempt one question from each section. Both examination papers will be single marked. Copies of Astronomy 1 past papers are held in the main library and can be accessed electronically. A selection of past papers, and model solutions, will be made available in due course via the Astronomy 1 Moodle site.

A compulsory class test examining first semester lecture materials will take place at the end of the first semester. The class test will comprise a series of six questions, each worth 5 marks; the test will be one hour long. Students should attempt all six questions.

The total assessment for Astronomy 1 will be weighted as follows: 55% from the two degree examination papers; 20% from the class test; 15% from the assessment of laboratory performance; 10% from the written tutorial assignments.

Marks awarded for the laboratory and assignment performances are based on all such work submitted for assessment expressed in terms of the maximum available mark. Students must therefore submit all written work requested in order to maximise their score.

The grades, and corresponding grade points, for Astronomy 1 are as follows:

Grade	Grade points per credit
A1, A2, A3, A4, A5	22, 21, 20, 19, 18
B1, B2, B3	17, 16, 15
C1, C2, C3	14, 13,12
D1, D2, D3	11, 10, 9
E1, E2, E3	8, 7, 6
F1, F2, F3	5, 4, 3
G1-G2	2, 1
H	0

A student's *Grade Point Average (GPA)* for the year is calculated as a weighted average using the credits per course taken (C_i) and the grade points per credit (P_i),

$$\frac{\sum_{i=1}^{n} P_i C_i}{\sum_{i=1}^{n} C_i}.$$

Entry into Astronomy 2 normally requires a grade D3 or above in Astronomy 1 as well as satisfactory progress in the remainder of your first year courses.

3.2.2 Minimum Requirements for the Award of Credit

To receive credit in this course, candidates must normally:

- attend at least half of the laboratory sessions and submit the associated work, AND
- submit at least half of the assignment exercises for marking, AND
- sit the sole class test, AND
- sit both the degree examination papers.

Note that candidates who do not meet these minimum requirements (except in the case of illness or other good cause) by the end of the first diet of examinations (April/May) will normally be awarded the grade CW (= 'Credit Withheld') for Astronomy 1.

If these requirements are not met by the end of the academic year (August), this grade will normally be transmuted to CR (= 'Credit Refused'). The award of 'Credit Refused' means that means that the credits associated with the course are not counted towards the minimum graduating curriculum, nor are they used in calculating the grade point average. This is a serious impediment to progress in *any* University subject.

A resit examination will be available in August for candidates scoring E1 or below (but not CR) in the first diet of examinations. Candidates' marks for the other assessment components (i.e. class test, laboratory and assignments) will be carried forward to the August Board of Examiners.

Assignments and laboratory work that were not submitted by their original deadlines and are required for the award of credit will be graded zero but will afford students the opportunity to avoid being refused credit (CR) for Astronomy 1.

3.2.3 Reassessment

Students should note that an opportunity for re-assessment will be provided **only** for the degree examination Papers 1 and 2 for Astronomy 1. For all other assessment components of Astronomy 1 there will be **no** re-assessment opportunity available, due to the impracticality of such provision. This is with the approval of the Head of School and following the recommendation of the Physics and Astronomy Learning and Teaching Committee.

3.2.4 Rules and Regulations

Display of Data

Section 3.3.2 of the University Calendar, "University Fees and General Information for Students", states: *'Schools and Colleges of the University may display personal data relating to their students, including the Data Subjects' name and registration number, on notice boards and the Intranet to provide information about seminar and tutorial groups, class test and examination results, and other essential information that has to be communicated to students. If an individual student objects to personal data being displayed in this manner, it is his or her responsibility to contact the relevant School.'* From time to time in Astronomy 1, we may use Moodle to publish assignment marks, laboratory marks and/or class test results. These results will be indexed against a student's ID number only (i.e.: names will be removed); degree exam results will be published using MyCampus.

Anonymous Marking

We have instituted a policy of anonymous marking for all assessment in Astronomy 1. We have done this to protect students and markers against the *possibility* of bias, whether conscious or unconscious. The policy applies to all continuous assessment in Astronomy 1 – assignments and laboratory work – as well as degree examinations and the class test (which are overseen by Registry). Therefore, please write **only** your Student ID on your assignments and laboratory work. If you accidentally write your name as well as your Student ID, please don't worry – our secretarial staff will blank it out for you before sending it out for marking. **Please have your Student ID card to hand when submitting and collecting work in**

Astronomy 1 as you may be asked to verify your identity. You may NOT collect work on behalf of other students.

Penalties for Late Submission of Assessed Work

Please note that, in line with University guidelines, it is the policy of the School of Physics and Astronomy to impose a penalty on continuous assessment work which is submitted late. This policy applies to all assignments and laboratory work. **10% of the maximum available mark for submitted material will be lost for every working day overdue. After 5 working days, a mark of zero will be awarded.**

In Astronomy 1, continuous assessment (labs, class test, and assignments) makes up **45%** of your final grade. So it is extremely important that **more** than the bare minimum required for credit. Every year students narrowly fail the course because they missed the odd lab or tutorial assignment without accounting for their absence – resulting in a zero score for that piece of work. Perhaps more surprising is the fact that every year there are students who get a B-grade instead of an A-grade due to failure to submit all pieces of continuous assessment.

3.2.5 Plagiarism

In Astronomy 1, part of the assessment comes from laboratory work and assignment work as already outlined. It is not our intention to stop you discussing laboratory results and your assignment problems with others in your class. Such discussions can be very useful in increasing your understanding of the subject. In the case of the laboratory work you can expect to work in small groups, and we encourage you to collaborate and share information freely. However your notes of the practical session, which are handed in and which will be assessed, should be an independent record of the afternoon's events and results. In the case of tutorial work, assignments, which are handed in for assessment, should again be an independent record of your attempt at the problems.

3.2.6 Calculators

Students should note that calculators with the facility to display information graphically, or having the capacity to manipulate formulae symbolically, are banned from use during examinations. Candidates must not bring such equipment into the examination hall. Any calculators of this type found during an examination will be removed, and the examination script endorsed accordingly. Students must comply with the following extract from the Calendar, General Information for Students:

No calculator, nor any other hand-held electronic device, may be used by a candidate in an examination except with explicit school approval. Such approval shall normally take the form of a published notice on school notice board(s) together with a statement incorporated into the instructions to candidates in the appropriate examination paper(s).

Calculators or other hand-held electronic aids with a facility for either textual storage or display, or for graphical display, are excluded from use in examinations.

Thus, **simple** calculators (with only the facility for numerical display) may be used in examinations. The calculator function on any mobile device (smartphone, laptop, iPad, tablet etc) may not be used in an examination.

3.3 Future Progress

We hope you will wish to continue to study astronomy for the rest of your academic career. Astronomy may be taken as a Combined Degree, e.g. with Physics or Mathematics. A grade of D3 or better from Astronomy 1 is normally a prerequisite for entry into Astronomy 2 (as well as satisfactory progress in the remainder of your first year courses). The following combinations of honours degree are possible: Astronomy and Physics, Astronomy and Mathematics, Applied Mathematics and Astronomy. Each combination is offered in the following degrees: MSci Combined Honours, BSc Combined Honours, and Designated Degree Combined. Students who study Physics and Astronomy at Level 1 may also wish to consider the Physics with Astrophysics MSci or BSc degree programme. More details on these options will be provided later in the session.

3.4 Attendance

Students are expected to attend all indicated lectures, tutorials and laboratory sessions. Attendance will be monitored at lectures, tutorials and labs. These attendance records will form part of the performance assessment (see below). Attendance at the class test and degree examinations is also compulsory.

Information on absence, good cause claims and other University policies may be found on the Senate Office policy page:

http://www.gla.ac.uk/services/senateoffice/policies/assessment

3.4.1 University Absence Policy

Students must complete an online **MyCampus absence report** for any significant absence from their classes. A significant absence is defined to be:

1. an absence of **more than seven consecutive days** during working periods
2. an absence of **any duration** if it prevents a student from:
    a. attending a class test or examination, or
    b. fulfilling any other minimum requirement for the award of credit (e.g. compulsory attendance at a laboratory, handing in an assignment, etc).

All potentially significant absences should be reported as soon as is practical, by completing part 1 of the MyCampus absence report. Part 2 of the MyCampus absence report should be completed on return to university. The normal submission deadline for the completed absence report is **7 days after return to University**. The Astronomy Board of Examiners will not necessarily take account of absences reported after this deadline. If at all possible, absences which will result in non-attendance at examinations or class tests should be notified **beforehand** by contacting the Class Head.

Documentary evidence is required when reporting any significant absence. The circumstances under which that documentary evidence should be a medical certificate are summarised in Table 1. Documentary evidence should be scanned electronically and linked to the MyCampus absence report. It is the responsibility of the student to keep all original documentation and submit it to the Class Head on request. For more information on absence reporting, and guidance on the process, see:

3.4.2 Good Cause Claims for Missed Assessment

If you miss an examination or an assessment deadline during this examination diet, or if you believe your assessment performance has been affected by adverse circumstances, you should submit a Good Cause Claim, and this must be via MyCampus.

Submission of a Good Cause Claim* is the mechanism which allows your circumstances to be considered by the Board of Examiners. Please note all Good Cause Claims must be submitted within a week of the date of the affected assessment.

To submit a Good Cause Claim on MyCampus:

1. Go to the "Student Centre" and select My Good Cause from the Academics menu.
2. Select the relevant course(s).
3. Complete the report in MyCampus (there is provision for particularly sensitive information to be provided separately, outwith the system, but a claim report must still be entered into MyCampus).
4. Add supporting evidence by uploading documents. (Scanners are available on level 3 of the University Library.

***If you miss an examination due to adverse circumstances submit a Good Cause Claim instead of an Absence report.**

If you encounter any difficulties with this process please contact the class head immediately to let them know you have a problem with your Good Cause Claim.

What will happen to your Good Cause Claim
The class head will ensure that your claim is considered and this will be in accordance with the section of the Code of Assessment which covers incomplete assessment and good cause (paragraphs 16.45 to 16.53). The outcome of your claim will be posted into the Approval Information section on your Good Cause Claim in MyCampus. If it is accepted that your assessment was affected by good cause, the work in question will be set aside and you will (as far as is practicable) be given another opportunity to take the assessment with the affected attempt discounted.

4 Course Component Details

4.1 Reading List

The course textbook for Astronomy 1 is:

An Introduction to Modern Astrophysics (2nd ed)
Bradley Carroll and Dale Ostlie**.**

Note that this book is also the recommended textbook for Astronomy 2, and is also highly relevant for many of the Honours Astronomy courses. Purchasing it therefore represents a worthwhile long-term investment. Individual course lecturers may recommend other, more specialised, textbooks for consultation, but Carroll & Ostlie is the only **essential** purchase.

4.2 Course Syllabi

4.2.1 Solar System Physics

Course content
The purpose of this course is to provide a description of the Solar System, its structure, formation and evolution. The basic physics of radiation, gases, and gravitation is introduced and applied to simple models of the Sun, planets and other bodies in the Solar System, and to models for the formation of the solar system.

The contents of the course are:

- *Qualitative Tour of the Solar System* – introduction to the Solar System; the Sun; the planets, dimensions, masses, composition, planetary satellites; minor bodies.
- *Newton's Law of Gravitation* – gravitational force & acceleration; surface gravity; escape velocity; tidal forces and lunar tides.
- *Physics of planetary atmospheres* – the gas laws; velocity distributions in a gas; light element escape from planetary atmospheres; hydrostatic equilibrium; scale height and the isothermal atmosphere.
- *Jovian planets* – key features; escape temperatures; internal structure; rotation; description of the ring systems; the Roche stability limit and ring formation; tides and tidal locking; description of the Galilean moons of Jupiter.
- *The Sun* – general properties; luminosity and the Planck spectrum, the Stefan-Boltzmann equation and Wien's Displacement Law; the solar interior, energy transport, radiative and convective regions; the outer layers of the Sun, the photosphere, chromospheres, corona and magnetic phenomena; solar wind; solar activity, sunspots and the butterfly diagram.
- *The Terrestrial planets* – overview, interior features, core, chemical composition of atmospheres; surface feature, cratering, volcanism, tectonics, erosion; interior features of the Earth, measuring the Earth, seismology, layers, rocks; radioactive decay and dating, half-life, parent & daughter elements, radioactive dating.
- *Planetary Heating* – radiogenic heating; simple derivation of the surface temperatures of the planets & albedo; the greenhouse and effect.
- *Minor Bodies of the Solar System* – classification of meteorites into stony and iron; asteroids; comets; meteoroids and meteorites.
- *Origins of the Solar System* – evidence for nebula hypothesis; angular momentum; age of Earth, Moon and other planets; extrasolar planets.

Learning Objectives: On completion of this course, the student should be able to:

1. describe the structure of the sun, the planets, the satellites and other minor bodies, and the structure and origin of the solar system
2. express the fundamental physical laws of blackbody radiation, gravitation, the gas laws and radioactivity
3. apply the above laws to describe and explain the properties of the bodies in the solar system and the evolution and formation of the solar system.

4.2.2 Positional Astronomy

Course content

This course is concerned with the general appearance of the night sky, particularly the apparent movement of the stars and planets. Celestial co-ordinate systems are introduced in their appropriate forms, with the requisite grounding in spherical trigonometry a key part of the course. The comparison of these co-ordinate systems with the familiar terrestrial latitude and longitude is emphasised throughout.

The material covered in lectures is as follows:

- *The Sphere* – explanation of the need for spherical geometry, definitions of great and small circles and the formulae relating them; spherical angles and spherical triangles; relation to spherical polar co-ordinates; radians and small angle approximations; terrestrial latitude and longitude, and definition of nautical mile; the cosine and other formulae
- *Geocentric Planetary Phenomena* – direct and retrograde motion; inferior and superior planets; phase angle and elongation; relation of phase angle to phase; maximum elongation of inferior planet and minimum phase of superior planet;

sidereal and synodic periods of planets; calculation of the maximum elongation of a planet.
- *The Celestial Sphere* – definition of terms: topocentric, geocentric, heliocentric; Alt-Azimuth co-ordinate system and position of north celestial pole; hour angle and declination; diurnal motion and circumpolar stars rising and setting; co-ordinate transformation via the triangle PZX (pole, zenith, star); right ascension and declination; local and Greenwich sidereal time; definition of the ecliptic and equinox; ecliptic latitude and longitude; relation of the equatorial and ecliptic co-ordinates via the triangle PKX (pole, ecliptic pole, star); annual variation of sun's co-ordinates; times of sunrise and sunset; examples of co-ordinate transformation and of the art of drawing celestial spheres.

Learning Objectives: On completion of this course, the student should be able to:

1. state the fundamental formulae of spherical trigonometry and be able to use and apply them to planetary motion and terrestrial navigation
2. describe the various co-ordinate systems (Alt-Azimuth, Equatorial and Ecliptic) and be able to transfer between them
3. solve problems concerning apparent motion of stars in the night sky

4.2.3 Dynamical Astronomy

Course content

This course introduces the student to Newtonian Gravitation, and its application to simple two body problems.

The material covered in lectures is as follows:

- *Planetary Orbits* – properties of ellipses and concepts of eccentricity, perihelion and aphelion; Kepler's laws of orbital motion
- *Newtonian Gravity* – Newton's law of gravitation; the gravitational constant G; surface gravity; convenient units for solar system calculations
- *Conserved Quantities* – angular momentum, gravitational potential energy, total energy
- *Orbits* – the escape velocity; parabolic and hyperbolic trajectories; centre of mass; satellite orbits, and specification by orbital elements; transfer orbits.

Learning Objectives: On completion of this course, the student should be able to:

1. state the basic concepts of Newtonian gravitation and associated phenomena.
2. Use these concepts quantitatively in various situations such as deriving surface gravity and escape velocities and determining properties of planetary orbits.

4.2.4 Stellar Physics

Course content

This course deals with the observations, classification, and modelling of stars and their evolution. The course divides into two parts: Stars and Compact Objects. The first part deals with the basic observations of stars in our galaxy, the different stellar types and their classification. We discuss the source of luminosity of stars, the structure of main sequence stars and their evolution off the main sequence. The second part deals with the later stages of stellar evolution and the properties of the so-called compact stars, white dwarfs and neutron stars, and black holes, and our theoretical understanding of these objects.

The material covered in lectures is as follows:

- *Measuring the stars* – the sun; range of stellar luminosities, masses and radii; effective temperatures.
- *Star types* – main sequence; red giant stars; white dwarf stars; variable and binary stars; light curves and radial velocity curves.
- *Classification of stars* – Hertzsprung-Russell (H-R) luminosity v temperature diagram; spectral classification; chemical composition, mass luminosity relationship for main sequence stars.
- *Stellar atmospheres* – photosphere, chromosphere, and corona; absorption; scattering; introduction to spectral line formation.
- *Stellar models* – hydrostatic equilibrium; estimates of central temperatures of main sequence stars; radiative equilibrium and convection; nuclear fusion; p-p chain and CNO cycle.
- *Stellar evolution* – typical evolution of 1, 5 and 10 M¤ stars; lifetimes of stars; H-R diagram and evolution.
- *Supernovae* – the sequence of events before, during and after a core-collapse supernova.
- *White dwarf stars* – electron degeneracy pressure; relativistic effects and Chandrasekhar mass limit; mass-radius relation.
- *Neutron stars* – pulsars; gravitational accretion as source of luminosity; neutron star mass limit.
- *Black holes* – mass limit for neutron stars; event horizons; Hawking radiation; gravitational waves.

Learning Objectives: On completion of the course, the student should be able to:

1. describe the main types of stars, the spectral classifications of stars, and the Hertsprung-Russell (HR) diagram
2. discuss the physical principles needed to build simple models of main sequence stars
3. discuss the relationship between stellar evolution and the HR diagram
4. explain the nature of gravitational collapse and be familiar with the properties of compact stars and black holes
5. state the observational evidence relating to these stellar states

4.2.5 Observational Methods

Course content

This course is concerned with the basic concepts and principles regarding the design and performance of observational instrumentation. The electromagnetic spectrum is introduced, with a discussion of observing windows in different wavelength regimes. The design and properties of telescopes and detectors in the visual, X-ray, ultra-violet, infra-red and radio are assessed, and limiting operating characteristics evaluated.

The material covered in lectures is as follows:

- *Electromagnetic (EM) radiation* – flux; polarization; frequency and wavelength; atmospheric windows; units associated with the various spectral regions used in astronomy; magnitude system.
- *Telescopes and their purpose* – telescopes as flux collectors; light gathering power; signal strength and conversion to photon flux; telescope efficiency; limits of source detection; angular resolving power.
- *Optical telescopes* – basic geometric optics; refractors and reflectors (Newtonian, Cassegrain, Coude); effects of Earth's atmosphere; active and adaptive optics; visual use of telescopes; magnifying power; limiting magnitude.
- *Basic instruments* – spectrometers; photomultipliers; CCDs; detector linearity.

- *Radio, UV and X-Ray astronomy* – space telescopes for UV and X-ray observation; radio antennas and the 2-element interferometer; basic techniques for infrared astronomy.

Learning Objectives: On completion of the course, the student should be able to:

1. describe the electromagnetic spectrum, associated units, and properties of the atmosphere in different spectral regions.
2. explain the use of telescopes as flux collectors, including quantitative assessment of angular resolving power, magnifying power, telescope transmission and limiting magnitude.
3. describe the main types of modern astronomical detectors (photomultipliers and CCDs), and explain the principles underlying their use.
4. apply their knowledge of the above directly to experimental measurements, and to solving quantitative problems involving the operation of multi-element telescope, instrument and detector systems.

4.2.6 Introduction to Cosmology

Course content

This course presents a brief outline of modern observational and theoretical cosmology. The expanding universe is discussed in the light of the big bang model.

The course contents are:

- *Galaxies* – the Milky Way; classification of galaxies; rotation curves and dark matter; redshifts; quasars; AGNs
- *Distance scales and structure of universe* – distance determination; the Local Group; clusters and superclusters
- *The expanding universe* – Hubble's law
- *Big bang cosmology* – cosmic abundances; critical density; age of the universe; radiation and matter dominated eras; decoupling of matter and radiation; helium production in the early universe; microwave background; structure formation.

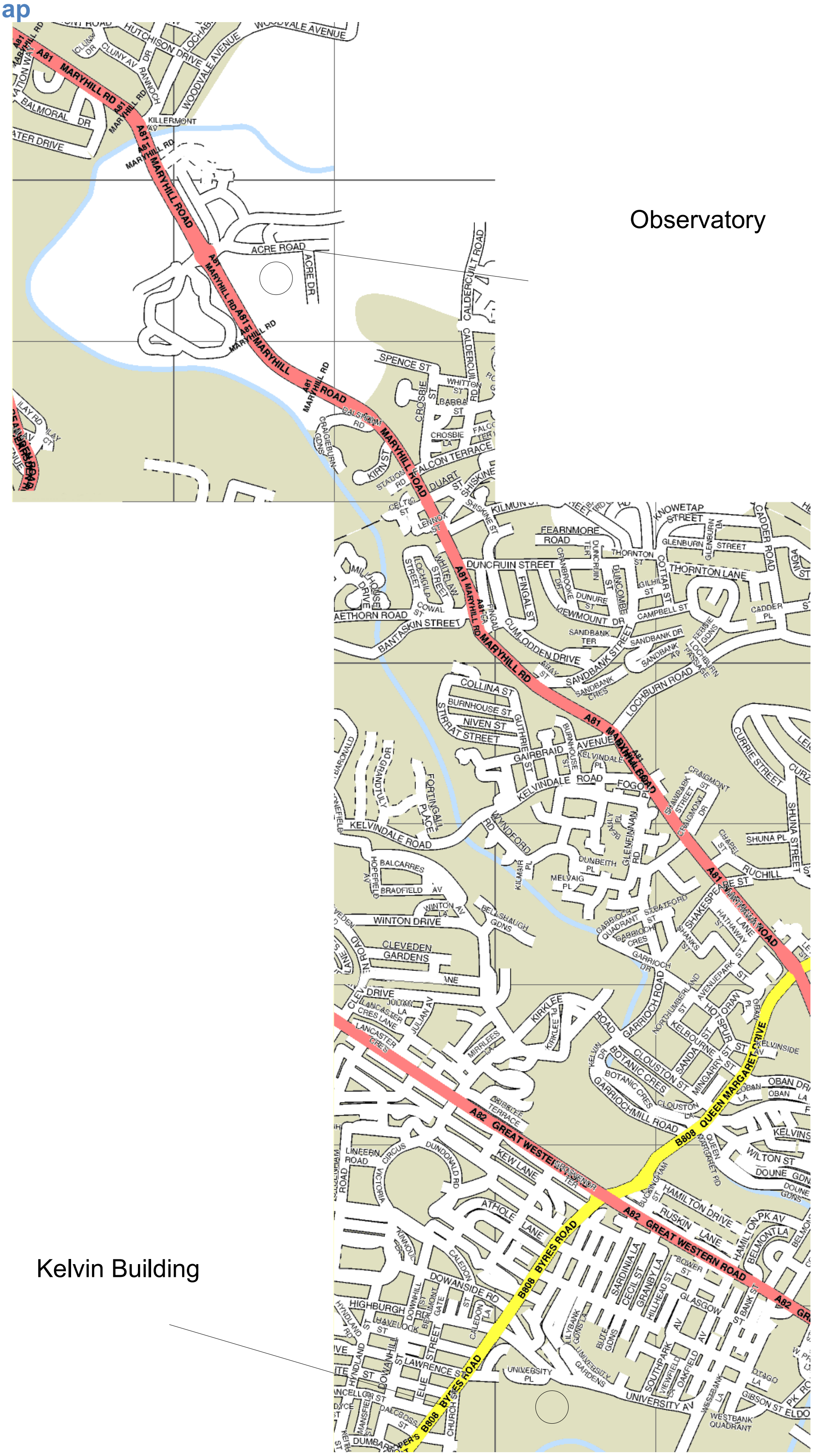
Learning Objectives: On completion of the course, the student should be able to:

1. describe the properties of the main types of galaxies
2. discuss the large scale structure (clusters and superclusters) in the universe and their relative scales
3. explain the Big Bang model and its status in relation to cosmological observations

5 Practicalities

5.1 How to Find the Observatory

5.1.1 Map



5.1.2 Travelling to the Observatory

The main-road distance between the Kelvin Building and the Acre Road Observatory is 5km (3.12 miles). Aiming for the most carbon-neutral method of travel, you should allow at least 50 minutes walking time. If you plan to cycle, allow at least 25 minutes and please be aware that the final approach to Acre Road is along a stretch of Maryhill Road which is dual carriageway with a speed limit of 50mph (and oftentimes some interesting potholes). Other routes are possible but students should bear in mind personal safety at all times in this large metropolitan city.

Otherwise, you may wish to take a bus -- public transport options in Scotland can be investigated at the *Traveline Scotland* website: http://www.travelinescotland.com

Alternatively, you might consider taking a taxi. There are taxi ranks on Byres Road (beside Hillhead underground station) and on Queen Margaret Drive (opposite the entrance to the Botanic Gardens). A fiscally intelligent method of doing this would be to join forces with several of your Astronomy 1 classmates and share a taxi.

Final approach to Acre Road, heading westwards along Maryhill Road:
There is a large roundabout on Maryhill Road, serving the Garscube Estate and Science Park. Take the third exit and head up the hill to a smaller roundabout, taking the second exit there. The turnoff to the Observatory is about 100m further along this road, again on the right. The green copper domes of the Observatory can be seen from here, so proceed up the path to the entrance, passing the Naval Architecture & Marine Engineering building on your left and the Wind Tunnel on your right; the Observatory is at the top of the hill.

5.2 Student Facilities in the Kelvin Building

5.2.1 Common room

The School's common room for staff and students is room 470. The common room has hot and cold drinks machines, a snack machine, kettles, a microwave oven and an egg-poaching device.

5.2.2 Student PC Clusters

Students enrolled in Astronomy 1 are permitted to use the School PC clusters.

5.2.3 Student Library

The student library is located in room 332. Some of the course textbooks can be found in the student library. Access information is usually displayed on the door of the library. An extensive reference library of textbooks can also be found at the Acre Road observatory.

5.2.4 Student Astronomical Society

The student astronomical society, AstroSoc, undertakes to arrange social events and invited talks on hot topics of relevance to modern astronomers. Why not liven up your academic life, and participate socially? Don't forget the other student organisation within the School, PhySoc, which runs many events jointly with AstroSoc.

5.2.5 Student-Staff Committee

Astronomy 1 elects two representatives to the School's Student - Staff Committee. Agendas and minutes of the committee meetings are posted on the School's Moodle sites.

6 Miscellany

6.1.1 Student Wellbeing

Please don't suffer in silence. If you have any difficulties with the course, whether in comprehension or related to personal circumstances, please don't be hesitant in broaching the subject with us. You may approach the class head, the laboratory head, the lecturers concerned or your adviser of studies. The University also provides counselling and study advice, and you can find information about that here:

http://www.gla.ac.uk/students/wellbeing/

6.1.2 Disability

If you have a disability, please let the class head know in advance. Every possible measure will be taken to make sure that you can participate in all activities. There is level entry to the Kelvin Building, and lift access to the lecture theatre and laboratories. Acre Road Observatory is all at ground level, except for the main dome, which can only be accessed via a spiral staircase. The basement level is only accessible by stairs but all experiments currently housed in the basement are not part of the level 1 curriculum.

Should you have a disability or special needs in respect of course work or examinations, please inform one of the University's Disability Advisers: details can be found on the web at

http://www.gla.ac.uk/services/disability/

6.1.3 Religious Beliefs

If you have religious beliefs that you feel may cause a problem with attendance at any lecture, tutorial, laboratory or examination then please notify the class head at the beginning of the academic year.