Stars, Galaxies and the Universe
29:50 - Dr. C. C. Lang
Final Exam
December 16th 2010
FORM A - *SOLUTIONS*

1. The universe is thought to be accelerating in its expansion. How do we know this?
   (a) through observations of dark energy, which we recently detected
   (b) by looking at the slope of H_o at early times (from SN Type 1a explosions)
   (c) by observing galaxy clusters
   (d) by detecting black holes in distant galaxies
   (e) We don't. The universe is thought to be expanding at a uniform rate.

2. About 300,000 years after the beginning of the universe, a very important event is thought to have occurred. What was it?
   (a) the creation of the Solar System
   (b) the formation of the Milky Way
   (c) the ability for an atom to remain stable and the universe became transparent
   (d) the first solar eclipse
   (e) inflation

3. If the Cosmic Microwave Background radiation is from the early universe, at a time when the universe was very hot and dense (the Big Bang), then why does it correspond to a temperature of only 3 K?
   (a) because the universe has expanded and cooled dramatically since the Big Bang
   (b) because much of the energy is released in the form of neutrinos
   (c) because most of the universe is made of dark matter
   (d) because the universe quickly cooled through 'deflation'
   (e) dark energy has absorbed most of the early energy

4. Which of the following best describes the types of exoplanets that have so far been discovered?
   (a) similar to the Earth and Mars
   (b) hot Jupiters close to their parent stars
   (c) brown dwarfs
   (d) very much like Venus, with thick atmospheres
   (e) Earth-like planets in very elliptical orbits around their parent stars

5. The *summer solstice* occurs around June 21st. In astronomy, what does this signify?
   (a) the most auspicious day for a wedding
   (b) the time of year when day and night are equal
   (c) the most Northerly location of the Sun in the sky
   (d) when the paths of the celestial equator and the ecliptic intersect
   (e) the most Southerly location of the Sun in the sky

6. Which type of spectrum do most stars like the Sun exhibit and why?

(a) emission lines of hydrogen, helium and a few other heavy metals, because stars are made primarily of hot gas

(b) continuous spectrum, since we consider stars to be perfect blackbody radiators

(c) absorption lines of hydrogen, helium and a few other heavy metals, because the interiors of stars are hotter than the cooler outer layers

(d) emission lines of neon only because many stars are red in color

(e) absorption lines of helium and mercury, because those are the most common elements in the universe

7. Two astronomers disagree on the value of Hubble's constant, H_o. Prof. Randy Redshift has measured it to have a value of 58 km/s/Mpc and Prof. Pauline Pulsar believes it to be 82 km/s/Mpc. Whose universe is *older*?

(a) Prof. Randy Redshift

(b) Prof. Pauline Pulsar

(c) Neither – H_o has nothing to do with the age of the universe.

(d) There is not enough information to figure this out.

8. Why are Cepheid variables often used to find the distances to galaxies?

(a) because they are intrinsically really bright

(b) they have a characteristic period of brightness changes and the period is related to the star's luminosity

(c) they are located very close to the Sun

(d) because they are really red

(e) their spectra are highly redshifted and can be easily identified

9. If you see the moon overhead at midnight, what is the phase of the moon?

(a) first quarter

(b) third quarter

(c) new moon

(d) full moon

(e) there is not enough information to determine

10. Which of the following types of electromagnetic radiation has the longest wavelength?

(a) x-ray radiation

(b) ultraviolet radiation

(c) infrared radiation

(d) radio waves

(e) none – all forms of electromagnetic radiation have the same wavelength

For questions 11-15, match the types of stars with the correct description (each answer will be used only once).

11. Neutron star **C**
12. Supernova Type Ia **D**
13. Supernova Type II **A**
14. White dwarf **B**
15. Supergiant **E**

(a) the explosion of a massive star (M > 10 M_o or so) after it collapses
(b) the corpse of a star that has a similar mass to the Sun
(c) the corpse of a massive star (M > 10 M_o or so)
(d) the explosion of a binary system (white dwarf and giant star) where the giant star dumps matter onto the white dwarf companion
(e) the post main-sequence phase of a massive (M > 10 M_o or so) star's evolution

16. If a neon beer sign (glowing neon gas) is viewed through a spectrometer, what type of spectrum would be seen?
(a) Nothing, neon gas has no spectrum
(b) A continuous spectrum with dark absorption lines
(c) A single absorption line characteristic of neon gas
(d) A 'bright line' spectrum – a pattern of emission lines characteristic of neon
(e) A series of photons with decreasing energies

17. Nuclear fusion in the core of the Sun releases energy in which two forms?
(a) x-ray and visible photons
(b) neutrinos and neutrons
(c) gamma ray and visible photons
(d) gamma ray photons and neutrinos
(e) Helium particles and photons

18. How does the value of Hubble's Constant (H_o) now compare to what it was in the early universe?
(a) it was the same as now – that is why it's called Hubble's constant
(b) it had a lower value at earlier times than it does now
(c) it had a higher value at earlier times than it does now
(d) there is not enough information to figure this out

19. Why can't an astronomer observe most of the infrared spectrum from the ground?
(a) the ozone and oxygen in the Earth's atmosphere absorb infrared radiation
(b) water vapor in the Earth's atmosphere absorbs infrared radiation
(c) it is cheaper to put a telescope in space rather than on Earth
(d) infrared rays pass through the Earth and it is not possible to observe them
(e) putting a telescope in space makes it physically closer to other stars and galaxies

20. How do we know that a 4 million solar mass supermassive black hole is located at the very center of our Galaxy ?
(a) the Sun is being slowly dragged into the Galactic center because of the black hole
(b) the center of the Galaxy has large and energetic jets rising up from its core
(c) its accretion disk is visible using large optical telescopes on Earth
(d) strong visible light is detected from the Galaxy's core
(e) the motions of surrounding stars are very high, suggesting the presence of a large dark mass

21. How is the tilt of the Earth's axis responsible for a summer being warmer than winter?
(a) the Earth is closer to the Sun in summer due to the tilt of the Earth's axis
(b) the Sun is more directly overhead in summer due to the tilt of the Earth's axis
(c) the Sun's tidal pull is stronger in summer due to the tilt of the Earth's axis
(d) the Sun rises due East in the summer
(e) the tilt of the Earth's axis is not responsible for the seasons

22. How is the luminosity of a star related to its mass when it is on the main sequence?
(a) a star's luminosity has no relation to its mass on the main sequence; only its age
(b) the luminosities of stars are too difficult to measure, so this is unknown
(c) lower mass stars have higher luminosities on the main sequence
(d) higher mass stars have higher luminosities on the main sequence
(e) a star's luminosity only depends on its surface temperature, not its mass

23. When a star is on the main sequence, what is occurring in its core?
(a) the star is fusing carbon into oxygen and iron
(b) the core of the star is rapidly expanding
(c) it is becoming a white dwarf
(d) the core of the star collapses into a neutron star
(e) the hydrogen in the core of the star is fusing into helium

24. Which of the following best describes Professor Lang's research interests?
(a) the study of hair and makeup practices of alien civilizations
(b) the study of supernova explosions in distant galaxies
(c) the search for exoplanets near the Sun
(d) the study of massive stars and the magnetic field in the Galactic Center
(e) the study of distant protostars which are thought to be forming planets

25. Which is NOT thought to be a location of dark matter in the universe?
(a) in the halo of our Galaxy
(b) in the outer regions of our Galaxy
(c) in the core of the Sun and most stars
(d) in the halo and outer regions of other galaxies
(e) in the centers of galaxy clusters

26. What is the source of energy powering a quasar or active galaxy?
(a) many simultaneous supernova explosions going off.
(b) gas in an accretion disk radiating and falling onto a supermassive black hole.
(c) a vigorous burst of star formation.
(d) movement of gas in the outer parts of the galaxy at very high speeds.
(e) strong magnetic activity in the outer parts of the Galaxy.

27. The outermost layer of the Sun is known as the _____ and is thought to be about _____ in temperature. The mechanism for its heating is a hot topic in astrophysics.
(a) chromosphere; 10,000 K
(b) granulated layer; 6,000 K
(c) convective layer; 100,000 K
(d) corona; 1-2 million K
(e) photosphere; 1-2 million K

28. Which technique has discovered the largest number of exoplanets (planets around other stars)?
(a) Looking for variations in the star's position in the sky, due to the gravitational pull of a planet orbiting the star.
(b) Looking for small Doppler shifts of the star's spectral lines, due to the gravitational pull of a planet orbiting the star.
(c) Looking for excess infrared radiation from the star due to a planet.
(d) Using space-based telescopes to search for tiny pinpoints of light that follow circular or elliptical paths around the star.
(e) Using ground-based telescopes to search for slight changes in the brightness of a star, due to an eclipsing planet orbiting the star.

29. During the night, the stars rise in the East and move from East to West. This phenomenon is due to
(a) the revolution of the Earth about the Sun.
(b) the motion of the Sun through the nearby stars of the Milky Way.
(c) a flow of stars through the inner solar system.
(d) the rotation of the Earth on its axis.
(e) precession of the Earth's rotation axis.

Questions 30-35 are True/False.

30. The luminosity of a star changes as you change your distance to the star.
(a) True
(b) False

31. The interior layers of the Sun are as follows (from inside to surface): core, radiative and convective.
(a) True
(b) False

32. A refracting telescope uses a series of lenses to focus the incoming cosmic light.
(a) True
(b) False

33. The ecliptic is the path of the Sun and Moon during eclipses.
(a) True
(b) False

34. Sunspots are cooler than the solar photosphere.
(a) True
(b) False

35. Astronomers are still trying to determine the value for Hubble's constant (H_o).
(a) True
(b) False

Questions 36-39: Please match the following locations on the H-R diagram to the type of stars below that one would find there. Each choice only used once.

(a) Upper Right
(b) Lower Left
(c) Main Sequence – Middle
(d) Main Sequence – Upper Left

36. White Dwarf **B**
37. Red Giant and Supergiant **A**
38. Sun **C**
39. 20 Solar Mass star with Luminosity Class V **D**

40. If you were to move the Earth to half its current distance from the Sun (to 0.5 AU), how would the gravitational pull on the Earth by the Sun change?

(a) it would be ¼ as strong at 0.5 AU
(b) it would be 4x as strong at 0.5 AU
(c) it would be ½ as strong at 0.5 AU
(d) it would be 2x as strong at 0.5 AU
(e) it would not change – gravitational force is not dependant on distance

41. Which of the following is NOT a true statement about neutron stars and pulsars?

(a) All neutron stars are pulsars.
(b) Pulsars are detected in the radio part of the electromagnetic spectrum.
(c) Neutron stars have intense gravity and can bend light.
(d) All pulsars are neutron stars.
(e) Massive stars collapse to form neutron stars.

42. Stars in a binary system orbit ___.

(a) on elliptical paths
(b) around the North Pole star
(c) in each other's Roche Lobes
(d) around a common center of mass, located closer to the more massive star
(e) around each other in perfectly circular orbits

43. A star has a surface temperature that is half as hot as the Sun – which of the following is a true statement?

(a) the star will have its peak intensity at a longer wavelength than that of the Sun
(b) the star will have twice as many sunspots as the Sun
(c) the star's internal temperature is twice as hot as the Sun
(d) the star is a Red Giant
(e) the star will have its peak intensity at a shorter wavelength than that of the Sun

44. Which two objects in the solar system (besides Earth) are the most likely candidates for finding evidence for some form of life?

(a) Mars and Saturn
(b) Jupiter's moon Europa and Mars
(c) Neptune and Jupiter's moon Callisto
(d) Saturn and Neptune
(e) Venus and Mars' moon Phobos

45. Which of the following best describes the Earth's Van Allen Belts?

(a) they are magnetic field lines which trap neutrinos from the Sun
(b) they are aligned with the path of the Moon's orbit
(c) they interfere with cellphone signals on the Earth
(d) they interact with high energy photons from the core of the Sun
(e) they are magnetic field lines which deflect and trap charged solar wind particles

Questions 46-50 are matching: each choice used only once.

At which wavelength would you

46. detect a signal from an extra-terrestrial civilization? **(C)**
47. detect a protostar? **(A)**
48. study emission from an accretion disk around a supermassive black hole? **(B)**
49. study the Sun's photosphere? **(E)**
50. study the T=3K background from the early universe? **(D)**

(a) infrared
(b) X-ray
(c) radio
(d) microwave
(e) visible

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Thanks for a fantastic semester – I had a lot of fun teaching this class!
Have a great winter break! And keep watching the skies…

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