

Team Name and Number:

NY Invitational 2016

Part 1

- Image 14 is a graph that relates to what DSO?
 - What technique, where a planet's spectrum is observed as it crosses in front of its parent star, was employed to create this image?
 - By using this technique, what substance was inferred to be present in the skies of this exoplanet?
- Which one of the following choices representing stellar evolution sequences using the images are **NOT likely** to occur?
 - 1 -> 10
 - 2 -> 11
 - 11 -> 10
 - 10 -> 5
- Which one of the following choices representing stellar evolution sequences using the images are **likely** to occur?
 - 1 -> 2 -> 8 -> 11
 - 2 -> 6 -> 17 -> 27
 - 3 -> 1 -> 5 -> 30
 - 14 -> 3 -> 1 -> 26
- Order the exoplanets within or relating to images and diagrams 14, 16, 20, and 22 from lowest to highest mass.
 - Which image shows an artist's depiction of what 51 Pegasi b may look like?
 - The majority of the exoplanets involved in this question are which type of exoplanet?
- Order the pre-main sequence stars within images 4, 6, 8, and 10 by their distances from closest to furthest.
 - Why would the brown dwarf of these images be the hardest to discover if these objects were located at similar distances?
 - Which of the images contains the pre-main sequence star that would evolve the fastest? Why?
- Which orbits its host star at a further semi-major axis, 55 Cancri f or Kepler 186f?
 - Both of these planets may have liquid water on their surfaces because they orbit in what region around their respective stars?
 - Despite them both having potentials for liquid water, why would it be better to visit Kepler 186f when searching for Earth-like life?
- Both the HR 8799 and HD 95086 systems have what type of disk?
 - HR 8799 demonstrates a common feature of these disks, which is an excess of what wavelength emission due to the disk?
 - This excess emission is commonly seen in protoplanetary disks as well. To distinguish, which type of disk should be more opaque?

8. What method was used to detect the exoplanets in image 29?
 - a. Typically what attachment is used on a telescope to block out a star's light and help better resolve the planet's light?
 - b. Is it easier to directly image an exoplanet in a face-on or edge-on orbit?
9. What method was used to discover 51 Pegasi b?
 - a. Why is this method not optimal for detecting Earth-like exoplanets?
 - b. According to current models, why would the formation of a Hot Jupiter like 51 Pegasi b disrupt the formation of an Earth-like planet?
10. Which image shows the DSO Barnard 68?
 - a. What type of nebula is Barnard 68?
 - b. The presence of what substance makes the nebula less see-through in the visible compared with infrared wavelengths in the image?
11. Images 2 and 3 contain which DSO?
 - a. Which of these images was observed in the IR region of the electromagnetic spectrum?
 - b. Olivine has been detected in a young protostar from the Spitzer IR image. This may help to explain why what cold outer-solar system objects also contain silicates that should require hot temperatures to form?
12. Image 13 shows light curves of which DSO?
 - a. Why are the multi-wavelength light curves significant for understanding exoplanet and brown dwarf atmospheres?
 - b. The light curve variability can be attributed in part to the presence of what in brown dwarf atmospheres?
13. Images 8 and 9 show which pre-main sequence star DSO?
 - a. The gap observed directly in Image 8 shows that this DSO has what type of disk?
 - b. What is one way that the spiral structures shown in Image 9 could form?
14. What method was used to discover GD 165B?
 - a. GD 165B was the first discovered of what spectral class of brown dwarfs?
15. Image 16 shows the direct imaging of which DSO system?
 - a. What feature of the planet in this system is considered to be extreme?
16. Why is it easier to use the transit method to detect Earth-like planets around stars like 55 Cancri or Kepler 186 compared to a star like the Sun?
 - a. How many exoplanets were discovered in the Kepler 186 system before Kepler 186f?
 - b. The cold temperature of these red dwarf systems imply that exoplanets in the habitable zone would be closer to the star, meaning they can be tidally locked. What does the rotational period of such exoplanets eventually get synchronized with?
17. Image 19 demonstrates a weather map of WASP 43b. These weather maps constrained what two aspects of the planet's atmosphere?
 - a. Why is it easier to detect the water found in Hot Jupiters like WASP 43b than in Jupiter?
 - b. The study also used previously developed techniques, including subtracting the majority of star light from a Hubble image to reveal the direct light from the planet, known as what?
18. Image 4 shows what type of pre-main sequence star?
 - a. What is the massive analogue of this type of pre-main sequence star?
 - b. This type of star could evolve into which of images 10, 16, 17, 22, 24, 27, and 29?

19. Order the DSOs M42, HR 8799, 55 Cancri, HL Tauri, and T Tauri by which contains the most to least developed planets.
- a. Which of the DSOs this year are like or may eventually become like WASP 18b?

Part 2

20. A star that has an apparent magnitude of 7.38 and an absolute magnitude of 5.39 is what distance away in pc?
21. An exoplanet orbits a host star at a radius measured as an angular size of $0.0147''$. If the system is 17.9 pc away, then at what distance does the exoplanet orbit the star in AU?
22. A star has a peak emitted wavelength of 432 nm. What is the star's temperature in K?
23. A star with a temperature of 8724 K and a radius of 1.54 solar radii has what luminosity in solar luminosities?
24. What is the planetary equilibrium temperature in K of an exoplanet orbiting 2.29 AU from a 1.38 solar radii star that has a temperature of 6315 K? Assume the exoplanet can be treated like a blackbody.
25. A light curve from a system with an exoplanet candidate has a transit depth measured of 0.00104. If the exoplanet orbits a 0.72 solar radius star, then what is its size in Earth radii?
26. An exoplanet orbits a host star at an orbital radius of 1.89 AU in 4.6 years. What is its orbital velocity in km/s?
27. The ratio of orbital velocities for a star to its planet is 0.0083. The system has an inclination derived of 75 degrees, and the mass of the star is 0.66 solar masses. What is the mass of the planet in Jupiter masses?
28. What is the density of a 3.28 Jupiter mass planet that has a radius of 2.1 Jupiter radii in g/cm^3 (assume it to be a sphere)?
29. What is the acceleration due to gravity in m/s^2 on a planet that has a mass of 0.69 Earth masses and a radius of 0.45 Earth radii?