

1. **DESCRIPTION:** Teams will demonstrate an understanding of **Star and Galaxy Formation and Evolution**.

**A TEAM OF UP TO: 2**

**APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**

- Each team may bring one of the following options containing information in any form and from any source:
  - two three-ring binders;
  - a computer/tablet and a three-ring binder; or,
  - two computers/tablets, of any kind.
- If three ring binders are used they may be of any size and the information contained should be attached using the available rings. The information or pages may be removed during the event. Sheet protectors and laminated sheets are allowed.
- Each team may bring two stand-alone calculators of any type to use during the event. If the participants are using a computer/tablet they may use the calculator app or other program on their device in place of a stand-alone calculator.
- Participants using computers/tablets as a resource should have all information stored so that it is available to them offline.**
- At the Event Supervisor's discretion, teams may access a dedicated NASA image analysis website (e.g., [js9.si.edu](http://js9.si.edu)) to answer JS9 questions. If so, teams with computers/tablets will be allowed to use the Internet. Supervisors will provide an alternative (e.g., proctor-supplied computer or screen shots) for teams that did not bring a computer/tablet.**

3. **THE COMPETITION:**

Using information which may include Hertzsprung-Russell diagrams, spectra, light curves, motions, cosmological distance equations and relationships, stellar magnitudes and classification, multi-wavelength images (gamma-ray, X-ray, UV, optical, IR, radio), charts, graphs and JS9 imaging analysis software, teams will complete activities and answer questions related to:

- Stellar **and galactic** evolution including stellar classification, spectral features and chemical composition, luminosity, blackbody radiation, color index and H-R diagram transitions, neutron stars, stellar mass and supermassive black holes, Type Ia supernovas, **galactic structure and interactions, quasars, AGNs, galaxy clusters and groups of galaxies, gravitational waves, gravitational lensing, dark matter and energy, warm-hot intergalactic medium (WHIM), and the Cosmic Microwave Background (CMB).**
- Use Kepler's laws, rotation and circular motion to answer questions relating to the orbital motions of galaxies; use the distance modulus, **Type Ia supernovas, Hubble's law and redshift to answer questions about Hubble's constant and the recessional velocities of and distances to galaxies.**
- Identify and answer questions relating to the content areas outlined above for the following objects:
 

i. <b>SN UDS10Wil</b>	xi. <b>The 3 Quasars</b>
ii. <b>NGC 2623</b>	<b>152156.48+520238.5</b>
iii. <b>GRB 150101B</b>	<b>153714.26+271611.6</b>
iv. <b>JKCS 041</b>	<b>222256.11-094636.2</b>
v. <b>MACS J0717.5+3745</b>	xii. <b>PSS 0133+0400</b>
vi. <b>MACS J1149.5+2223</b>	xiii. <b>PSS 0955+5940</b>
vii. <b>Bullet Cluster (1E 0657-56)</b>	xiv. <b>GW151226</b>
viii. <b>H1821+643</b>	xv. <b>M87</b>
ix. <b>GOODS-S 29323</b>	xvi. <b>3C 273</b>
x. <b>H2356-309</b>	

4. **SCORING:** All questions will have been assigned a predetermined number of points. The highest score wins. Selected questions will be used to break ties.

**Recommended Resources:** The Science Olympiad Store ([store.soinc.org](http://store.soinc.org)) carries the Astronomy CD, the Bio/Earth Science CD, and field guides; other resources are on the event page at [soinc.org](http://soinc.org).

**This event is supported by NASA's Universe of Learning Astrophysics STEM Learning and Literacy Network**