ASTRONOMY

1. **DESCRIPTION:** Teams will demonstrate an understanding of stellar evolution **in normal & starburst galaxies**.

   A TEAM OF UP TO: 2   **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one of the following **options containing information in any form and from any source**:
      i. two three-ring binders;
      ii. a computer/tablet and a three-ring binder; or,
      iii. two computers/tablets, of any kind.
   b. 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.
   c. 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 a calculator app or other program on their device in place of a stand-alone calculator.**
   d. No Internet access is allowed during any part of this event. **Participants using computers/tablets as a resource should have all information stored so that it is available to them off-line**.

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 (X-ray, UV, optical, IR, radio), charts graphs and **JS9 imaging analysis software**, teams will complete activities and answer questions related to:
   a. Stellar evolution, including stellar classification, spectral features and chemical composition, luminosity, blackbody radiation, color index and H-R diagram transitions, **star formation**, Cepheids, **RR Lyrae stars, Type Ia &** Type II supernovas, neutron stars, pulsars, stellar mass black holes, **supermassive black holes**, X-ray & gamma-ray binary systems, **ultraluminous X-ray sources (ULXs), globular clusters, stellar populations, normal & starburst galaxies, galactic structure and interactions, gravitational waves**.
   b. Use Kepler's laws, rotation and circular motion to answer questions relating to the orbital motions of binary systems **and galaxies**; use parallax, spectroscopic parallax the distance modulus, **the period-luminosity relationship**, Hubble's law and **the Tully-Fisher relationship** to calculate distances.
   c. Identify and answer questions relating to the content areas outlined above for the following objects:
      i. **M51/NGC 5195**
      ii. **IC 10**
      iii. **SPT 0346-52**
      iv. **M81/M82**
      v. **ESO 137-001**
      vi. **SN2014**
      vii. **Phoenix Cluster**
      viii. **NGC 4993**
      ix. **47 Tucanae/X9**
      x. **Chandra deep field-south**
      xi. **Cen A**
      xii. **M100**
      xiii. **Abell 400/NGC 1128/3C 75**
      xiv. **Antennae Galaxies**
      xv. **Sagittarius A***

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

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Astronomy and Bio/Earth Science CDs; other resources are on the event page at soinc.org.

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