# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**

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**Project Number**

**S1911**

**Project Title**

## A Dying Star: The Effects of the Post-Main Sequence Sun on the Biological Sustainability of Various Solar System Objects

**Abstract**

**Objectives/Goals**

This study was conducted with the primary objective of determining which Solar System object(s) would be most viable during various stages of stellar evolution. Another goal of the research was analyzing the procedure to gauge feasibility in extrasolar planetary research.

**Methods/Materials**

The objects selected have evidence pointing toward the surface existence of presently frozen or liquid organic compounds or water [Wong, Rivkin, Morrison].Using the Evolve ZAMS software, the raw outputs of solar luminosities were used to calculate equilibrium temperatures on selected objects in the following manner: The temperature variable in the Stefan-Boltzmann equation was solved given the object's albedo, radius, and semimajor axis length [Zeilik]. From this, the ability of the surface substances to be gravitationally bound to the object was determined using statistical analysis of the RMS speed when compared to the escape velocity on the object.

**Results**

Temperature: Pre-helium flash, Triton will have a temperature of 255K and Enceladus, 203K. Post-helium flash, Io will have a temperature of 304K, Europa, 296K, Ganymede, 339K, and Titan, 272K. When the sun is a developed asymptotic branch giant (AGB), Triton will have a temperature of 260K, and Enceladus, 208K. Atmospheric composition: No gases can exist on Triton or Enceladus prior to the helium flash. Molecular nitrogen, molecular oxygen and carbon dioxide can exist on all the Jovian moons with viable temperatures, and Titan, just after the helium flash. No gases can exist on Triton or Enceladus when the Sun is an AGB star.

**Conclusions/Discussion**

This research can be interpreted in a multitude of ways, depending on the needs of humanity in the future. If water is a priority, Enceladus would be the best option, as its surface composition in the pre-helium flash and AGB stages indicate. If viable temperatures were of greater importance, Triton would be the better option. Post-helium flash, either Europa or Titan with water on the former and organic compounds on the latter, would be the best options for continued survival. Secondary objective: as the equilibrium temperature estimates for all the objects at present closely (<10%) approximate the actual temperature, the same method can be extrapolated to other planetary systems. This has major implications for astrobiology research as the field of potential objects can be narrowed down for more focused study.

**Summary Statement**

This study is about the effects of the latter stages of the sun on the Solar System and how the same methods used have applications in other planetary systems.

**Help Received**

I used the Evolve ZAMS program provided by Dr. Bill Paxton at UC Santa Barbara.