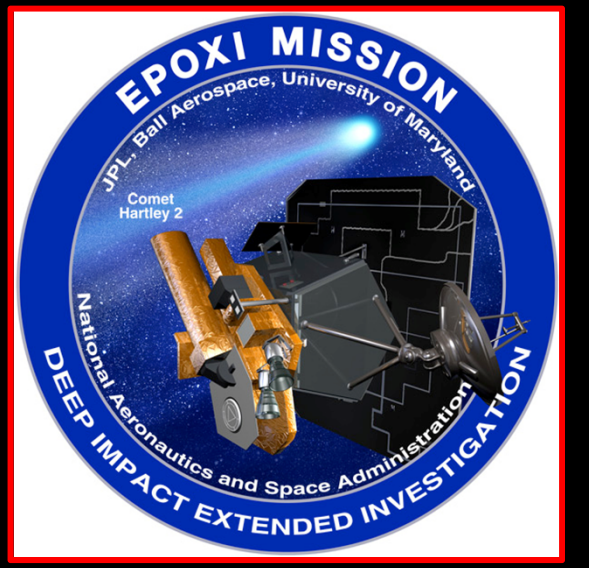
"BUILDING THE FOUNDATIONS FOR STUDENT OBSERVATIONS USING NASA'S DEEP IMPACT SPACECRAFT"

By Jamie Vargas
California State University, Fresno
Mentor: Rich Rieber



Educational Purpose of this Project

- In the classroom students are often given classical physics problems.
- Students want and deserve to work on real world problems.

The proposed program

- There are 3 phases for implementation of the student run observation using the DI equipment.
- Each Phase gets progressively more complex and becomes more independent in regards to student participation.

Phase 1: “Eye Candy”

- Public is allowed access to raw data.
- Students are encouraged to compile the images and communicate with other aspiring scientists via a public mission site and/or blog.

Member: machi

Member: NGC3314

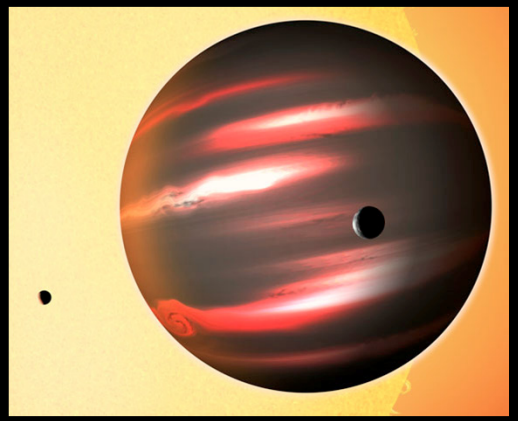
Courtesy of UnmannedSpaceFlight.com

Phase 2: Target Selection

- Public (Students) are given several targets to choose from.
- Discussion between students occurs for 2 – 4 weeks.
- DI Team will make selection based on survey results of targets.
- Students will then conduct a process similar to Phase 1.
- Student will produce a brief summary of their findings on the public website.

Phase 3: Field Proposals from Students

- Students write a proposal for conducting scientific observations of exoplanets and other deep space objects.
- DI Team will select one of the proposed missions.
- Team selected will receive the data form this observation 6 months before it is made public.
- Students will have the opportunity to publish their results as a CO- I researcher in a journal (i.e. Astronomy Education Review or *The Astronomical Review)*



http://spaceinfo.com.au/2011/08/13/alien-world-is-blacker-than-coal/

Making the Connection

Lesson Plans for Phases 1 and 2

- There were two routes in terms of using the archived images provided by the science team.
- Image processing (making a color photo)
- Image analysis (generating light curves)

Image Processing

- Not just pretty pictures. (Composition Maps)
- All images produced by the spacecraft are in a 16 bit FITS format

Colored image processing requires

- Stacking software capable of opening and manipulating 16 bit FITS
- Software that is capable of reducing the noise from cosmic rays
- Example Software: GIMP, Registax, FITS Liberator, Photoshop, Nebulosity

Image Analysis

Good:

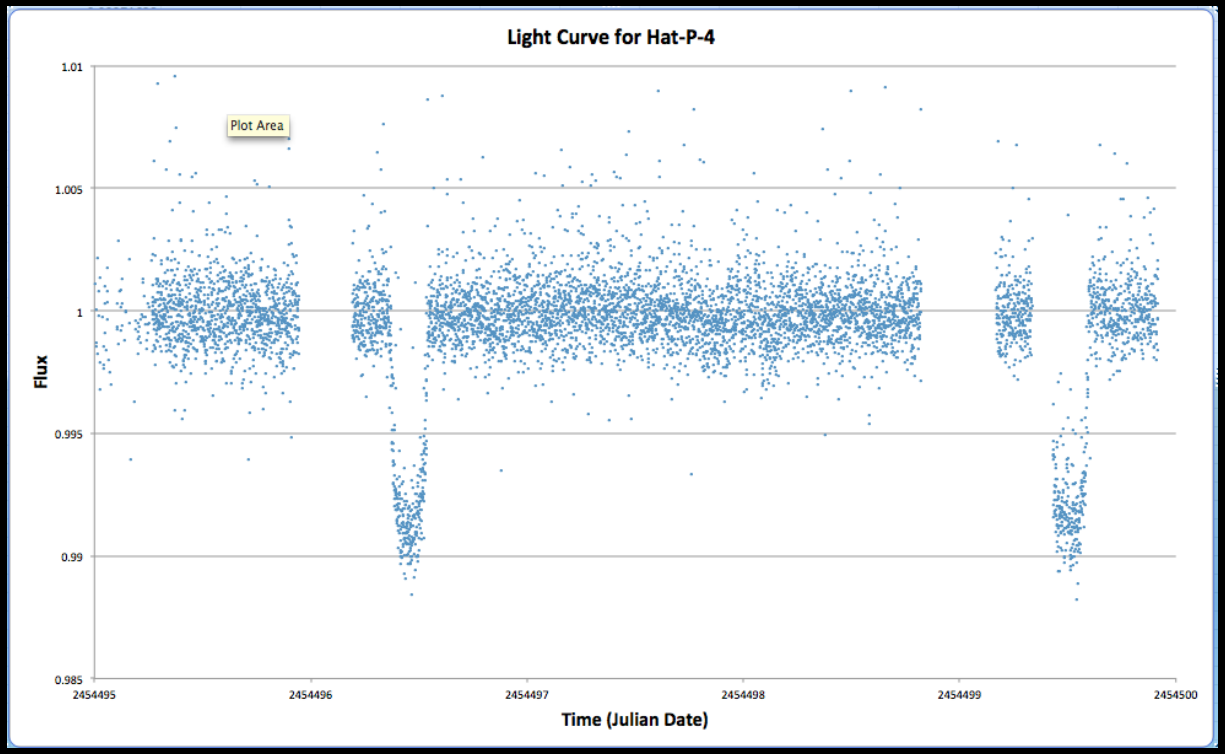
- Light curves are very useful in terms of characterizing the orbits and atmospheres of exoplanets.
- High Student Interest

Bad:

- Light curves are hard to make!!!!

Image Analysis

- Solution: Use previously composed light curves that are available via the Deep Impact Science Team.



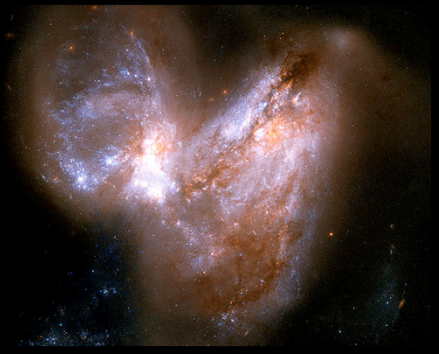
- With the data that is archived by the DI Science Team I was able to make 3 activities that relate light curves to Kepler's 3rd Law.

General Guideline for Phase 3

- “Eye Candy 2” modeling the guidelines for student observations
- Two objects NGC 3690 and M82 will be observed on 8/22

Things to consider when creating a science campaign

- Scientific purpose of observation
- Objects available based on spacecraft's location
- Angular size of object and amount of pixels covered on CCD
- Memory necessary for capturing images
- Time for downlink to Earth



Conclusion

- Phases 1 and 2 could be implemented without any major work.
- Educators have two options in terms of using the data provided by the DI Flight and Science Teams.
- This program is recommended for the time that teachers have after state testing is finished.
- Phase 3 is challenging yet highly rewarding for a high school student

Future Work

- Setting up a website that allows students and educators to work collaboratively with scientists.
- Phase 3 is very demanding and would take a lot of work on the part of educators if this is going to succeed.
- Creating more structure for the activity since it is time consuming in an educational world governed by standardized tests.
- Processing “Eye Candy 2” images

References

- J. L. Christiansen et al., "STUDYING THE ATMOSPHERE OF THE EXOPLANET HAT-P-7b VIA SECONDARY ECLIPSE MEASUREMENTS WITH EPOXI, SPITZER, AND KEPLER." *Astrophysical Journal*. 710. (2010): 97–104. Print.
- J. L. Christiansen et al., “System Parameters, Transit Times, and Secondary Eclipse Constraints of the Exoplanet Systems HAT-P-4, TrES-2, TrES-3, and WASP-3 From the NASA EPOXI Mission of Opportunity,” *The Astrophysical Journal*, vol. 726, no. 2, p. 94, Jan. 2011.
- D. L. Hampton et al., "AN OVERVIEW OF THE INSTRUMENT SUITE FOR THE DEEP IMPACT MISSION." *SPACE SCIENCE REVIEWS*. 117. (2005): 43-93. Print.

Acknowledgements

Special Thanks to:

- Rich Rieber
- Aimee Meyer
- Steve Wissler
- Ken Klaasen
- Doug Ellison
- And the rest of the DI Flight and Science Team
- Petra Kneissl-Milanian
- Dr. John Keller
- Dr. Bryan Rebar
- Martin Mathews
- Dr. Gerald Simila

Jet Propulsion Laboratory
California Institute of Technology

STAR

NASA Jet Propulsion Laboratory
California Institute of Technology

NSF

- NSF Grant No. 0833353
- NSF Grant No. 0952013