The WISE/HOU Student/Teacher/Scientist Asteroid Search

Developing a Meaningful Strategy that is Useful in Classrooms and Allows Teachers and Students to Become Part of the Scientific Journey

See http://handsonuniverse.org/

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Outline of Talk

I. Existing Successes and Capabilities of HOU Asteroid Search System

II. Some Capabilities of WISE -- WISE is AMAZING!!

III. Challenges
Always Remember: **Kids and Teachers Love Asteroids!!**

I. They move  
II. They rotate  
III. They are tinier and “chunk size” than galaxies, etc.  
IV. They eradicate Dinosaurs  
V. Etc.!
HOU Capabilities Poised for Wise

I. Software for finding and measuring asteroids
II. Curriculum/tutorials on how to do asteroids
III. 700 Trained teachers -- more as HOU goes to publication (in process now)
IV. TRA Core (~25 master teachers) to train and support regional teachers in emerging HOU Centers across the nation
V. Growing Telescope Network -- note HOU 30” (20th magnitude limit) and Faulkes (23 magnitude)
VI. Collaboratory Structure to Carry Out Research, Projects, and Publications
Anticipated Use Patterns for Wise

I. Physics and Astronomy classes -- “what is an asteroid and discover/re-discover one for a three day journey -- learn solar system dynamics

II. Middle school -- find one and understand size and solar system constituents -- one week.

III. Astronomy Classes -- part of extended HOU work -- two months, measure brightnesses, rotation curves, follow-up asteroids with HOU telescopes, etc.

IV. Extended Projects through Collaboratory: Six month projects -- Intel Science Competitions, etc.
What is an Asteroid Search?

- The Hands-On Universe Asteroid Search is a bridge between science education and science research. The Asteroid Search uses a powerful image processing/data analysis software package to search images for asteroids.
This is a subtracted image. The white and black dots in the upper left corner represent an asteroid.
This Works! HOU Students Discovered the 70th TNO!

- Made BBC, NY Times, etc.
HOU Curriculum

- **Introduction** to Image Processing
  - Explains how to use the HOU Image Processing Software toolbars. Students learn how a CCD detector digitizes celestial images, etc.

- Finding Features
  - Enjoy a Browser's Guide to the Universe. Play with images of lunar features and a solar eclipse.

- Measuring Size *
  - Use the pixel plate scale to measure a lunar crater. Track Jupiter's moons, etc.

- Measuring Color *
  - Learn about the colors of stars, the HR diagram, and how stars evolve according to their mass.
HOU Curriculum (continued)

• Measuring Distance *
  Learn how the cosmological distance ladder is used to determine the distance to far away objects. Practice using spherical geometry.

• Measuring Brightness *
  Learn about photometry -- measurement of light from a celestial object. Calculate stellar magnitudes using logarithms.

• Searching for Supernovae
  See how astronomers find supernovae -- exploding stars. Learn to manipulate pairs of digital sky images to reveal changes from night to night.

• Teachers’ Reference Guide
  This manual provides a description of how teachers can use the tools of modern astronomy in the classroom. Teacher notes are provided for each of the seven modules in the HOU curriculum, with guidelines for student outcomes.
Collaboratory System for Extended Projects or Explorations

- Safe environment for sharing work with peers and mentors
- Student and Teacher Journal of Astrophysical Research and Explorations
- Transient/Variable Objects are Best!

The Collaboratory Project

Note: Because of a major system updates, the Collaboratory will be off-line from Monday, December 27, 2004, to Monday, January 3, 2005.

We look forward to seeing you back on line in January!

Happy Holidays,
The Collaboratory Staff

The Collaboratory Project is a Northwestern University initiative that provides project consulting, training, technical advice, and Web-based resources and services to K-12 teachers and their students who are interested in using Internet technologies to advance education.

The Collaboratory is an easy-to-use, web-based collaborative environment that teachers use to develop project-based activities that are linked to Illinois Learning Standards.
HOU Tutorials Per Asteroid Search

- On HOU Research Web pages, with instructions for how to do it and use data bases
- Data Bases and organization crucial. Scientists do not nor cannot organize things well enough for students and teachers!
- Must make it easy and common-sensical for students, and also how to follow up, do calculations, etc.
HOU Asteroid Front Page

Hands-On Universe™ Asteroid Search

A joint venture of

Hands-On Universe

Supernova Cosmology Project

DeepLens Survey

Introduction | Tutorials | Join Search | Download Images
Data Analysis | Submit Data | Additional Resources

Hands-On Universe is grateful for support from the National Science Foundation, the US Dept. of Energy and the US Dept. of Defense.
So you found an asteroid candidate... Now What?

1. Submit a Candidate Data Form to the temporary database.
2. Fill candidate form with data from up to nine observations of the SAME asteroid.
3. List entries in temporary database and select data to send to partner school for confirmation.
4. Submit verified data to the permanent database.
5. Select confirmed data in temporary database to submit to permanent database.
6. Predict RA and DEC of asteroid for other dates. Check available images for more data points.
HOU Teachers

• Teachers go through carefully constructed and tested workshops, either face-to-face or on-line/CD based.
• Approximately 700 US teachers, and 700 around the world have taken some HOU workshops (including Middle school teachers)
• On-line workshops seem to work as well as face-to-face workshops. (TIMMS Study)
HOU TRA’s

• Teachers who are leaders, have been (hyper)active in HOU for 3 years
• 25 or so great teachers -- they have trained the 700 US teachers.
• Many have been with HOU for 10 years.
• At least one Presidential Awardee (Curtis Craig) -- probably more.
HOU Telescope Network

- Plans to connect more and more robotic telescopes for follow-up (the map below are not HOU telescopes yet, but we have about 10 willing to join already):

  ![Map of World Population of Robotic Telescopes](image)

  *Figure 1: The world population of (unconnected) robotic telescopes*

- Faulkes Telescope Collaboration (2-meter telescopes for follow-up and determining orbits better -- discussion in progress)
WISE Capabilities!

- See http://www.astro.ucla.edu/~wright/WISE/
- 2.75" pixels, 1024x1024 arrays, and take an image in 4 IR bands every 11 seconds.
- A given spot on the ecliptic will typically be imaged every other orbit, or every three hours, for about a day and a half.
- At 12 microns on the ecliptic we reach 650 microJy 5 sigma in 8 frames. This gives $\nu F_\nu$ of $1.6 \times 10^{-13}$ erg/cm$^2$/sec. Asteroids are about 10% albedo, so expect 2.5 microJy at V or about V=23. faint limit
- 2 kilometer size (??) check
Comparison To Ground-based Systems
(5 sigma in one hour):

Remember: WISE gets to 23rd V magnitude in 88 seconds
Why Is Wise Well-Suited to Finding Asteroids:

- Goes Faint FAST
- Multiple Re-images! (check for movement)
- Can explore Small Asteroids and TNO’s
- 23rd Magnitude is well-matched to Faulkes follow-up capabilities
Discovery Rate:

- See: http://home.cwru.edu/%7Esjr16/advanced/solarsystem_main.html

- Main Belt ~ 30 main belt asteroids per square degree -- > 15 main belt asteroids per frame on ecliptic (200,000) known. But this is lower limit as detection limits are set by current technology (this abscissa is mislabeled below -- should read “apparent magnitude”):
Discovery Rate Continued:

• Can explore Small Asteroids and TNO’s!!
• 23rd Magnitude is well-matched to Faulkes follow-up capabilities
Challenges to Students to Finding Asteroids:

- Database organization and maintenance
- Follow-up by scientists
- Making sure students have some data or part of the sky “reserved” for them
- Any re-point capability, if something interesting found??
Potential Challenges in General:

• Keep HOU Thriving and Well!
• Get Data to Kids Quickly!
• Interference from Scientific Community on Data rights