Igniting Curiosity!

and

Enriching your Curriculum

with

Front-Page Astronomy

John Percy

Department of Astronomy & Astrophysics &
Ontario Institute for Studies in Education
University of Toronto
John.percy@utoronto.ca

Outline

(this presentation is on my website)

- Philosophical/pedagogical statements
- Human interest and impact
- Canadian content; what taxpayers should know
- Sky phenomena: observable (or not); comet ISON
- Big ideas

What's “Front-Page Astronomy”?

- Human-interest stories
- Human-impact stories
- Current research discoveries/developments
- Canadian connections
- Extremes: biggest, furthest ...
- Sky phenomena (visible or not)
- Offbeat topics e.g. supermoons, blue moons
- Big ideas

What's “Front-Page Astronomy”?

- Human-interest stories
- Human-impact stories
- Current research discoveries/developments
- Canadian connections
- Extremes: biggest, furthest ...
- Sky phenomena (visible or not)
- Offbeat topics e.g. supermoons, blue moons
- Big ideas (sometimes)

What's “Front-Page Astronomy”?

- Human-interest stories
- Human-impact stories
- Current research discoveries/developments
- Canadian connections
- Extremes: biggest, furthest ...
- Sky phenomena (visible or not)
- Offbeat topics e.g. supermoons, blue moons
- Big ideas
- Chris Hadfield

What Do We Want Students to Learn?

- **Content:** especially fundamental concepts and “big ideas” (curriculum pg. 47)
- **Skills:** generic skills, and specific astronomical skills; astronomy is an observational science
- **Applications:** not just economic but cultural and intellectual?
- **Attitudes**: positive attitude to the subject: interest, excitement, enthusiasm, wonder (is this anywhere in the curriculum document?)

What Are Grade 9 Students* Interested In?

Krstovic et al., *Astronomy Education Review,* Vol. 7, #2, 18-24 (2008)

- Black holes (less so for girls)
- Extraterrestrial life
- Space exploration
- Cosmology

* and other students, I suspect

“Problem” with Teaching Astronomy

- Lack of hands-on or eyes-on activities: (“the stars come out at night, the students don't” -- Doug Paul)
- Is it sufficient to engage students' minds with these “big ideas”, and concentrate on understanding, applying, explaining, demonstrating, and communicating them?

Science Skills Developed

Reading/writing Front-Page Science

- Understanding background
- Close, careful reading for content and significance
- Critical reading of language, style, illustration
- Identifying, choosing, organizing, and using information
- Clear, concise writing for specified audiences
- Choice of images, diagrams, graphs
- Many relevant careers!

Cross-Curricular Connections
and the sciences are interconnected!

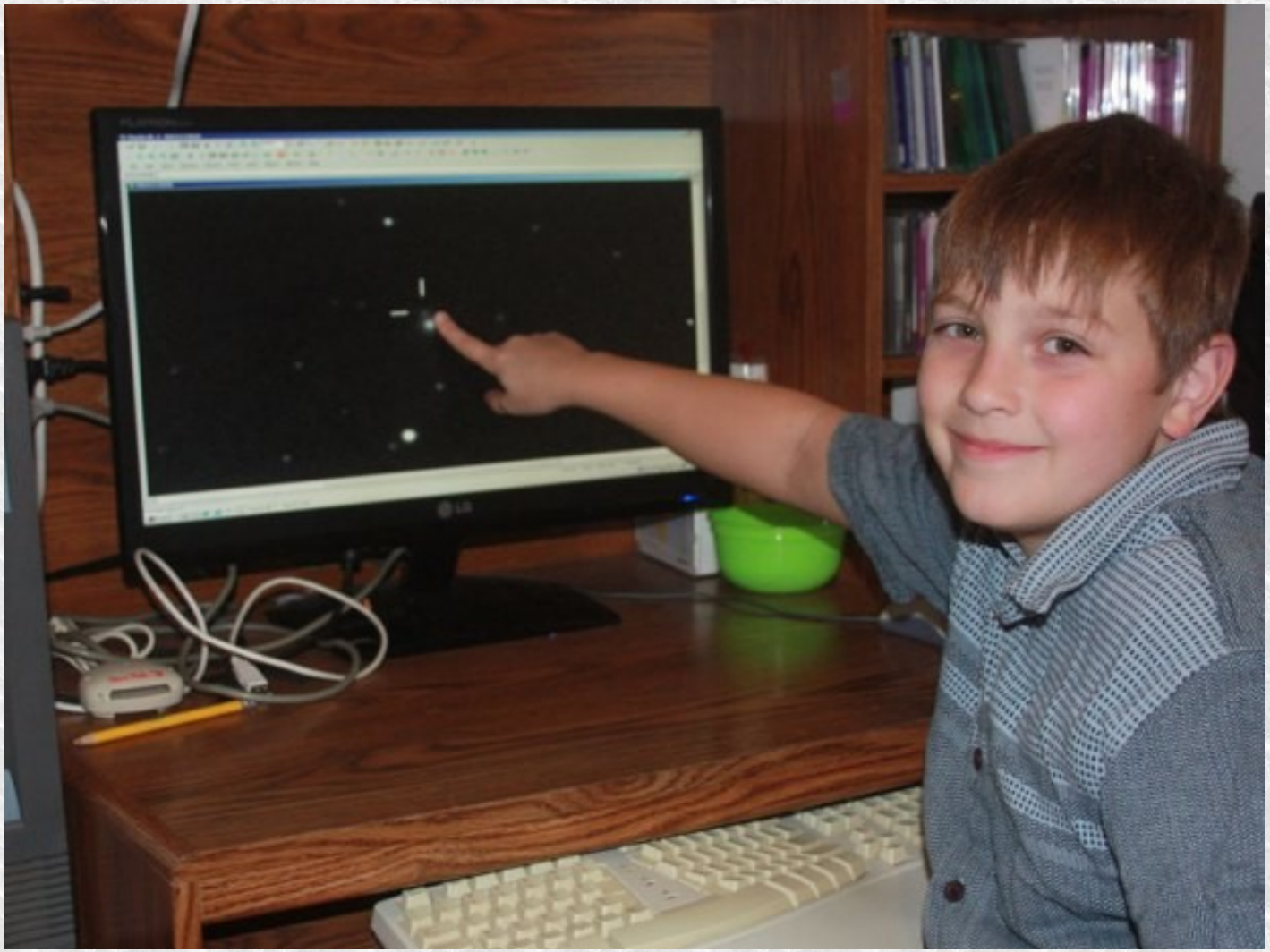
- **Physics:** engaging applications of gravity (orbits, space travel, black holes), light and optics (telescopes), atomic and nuclear physics (sun's energy sourse, origin of the elements).
- **Biology:** our cosmic origins; the origin of life; the diversity of life; life in space; extraterrestrial life.
- **Chemistry**: the origin of the chemical elements; molecules in the universe; spectroscopic determination of the composition of celestial objects
- **Earth Science:** the diversity of planets in our solar system and beyond; processes which shape these planets; the sun and climate

Human-Interest Topics

Science is done by people, not textbooks

Ten-Year-Old Discovers Supernova!!

Your students could do it, too!



Toronto Star, November 5

Sara Seager (BSc U of T)
MacArthur "Genius" Award

- Now MIT astronomer
- Expert on exoplanets, their atmospheres, prospects of extraterrestrial life
- Keen on outreach
- Word "genius" intrigues the press!

Two-page spread in the Globe And Mail, September 26

David Dunlap Observatory

Endless articles ...

- Big bad developers (and University of Toronto)
- The present status of DDO – still alive!
- The present status of the proceeds: a new Dunlap Institute with a strong commitment to outreach

Closing of “The Centre of the Universe”

- Visitors centre at the Dominion Astrophysical Observatory in Victoria
- Served the public, and especially schools
- Indicative of the federal government's attitude to science?
- Provoked an editorial in the *Toronto Star*

The McLaughlin Planetarium

- The sad and unnecessary story
- The present status of the McLaughlin Planetarium; present status of plans for a new planetarium
- But: ROM has an active astronomy program!

Great Canadian Astronomers

Helen Sawyer Hogg

Richard Bond

Ray Jayawardhana

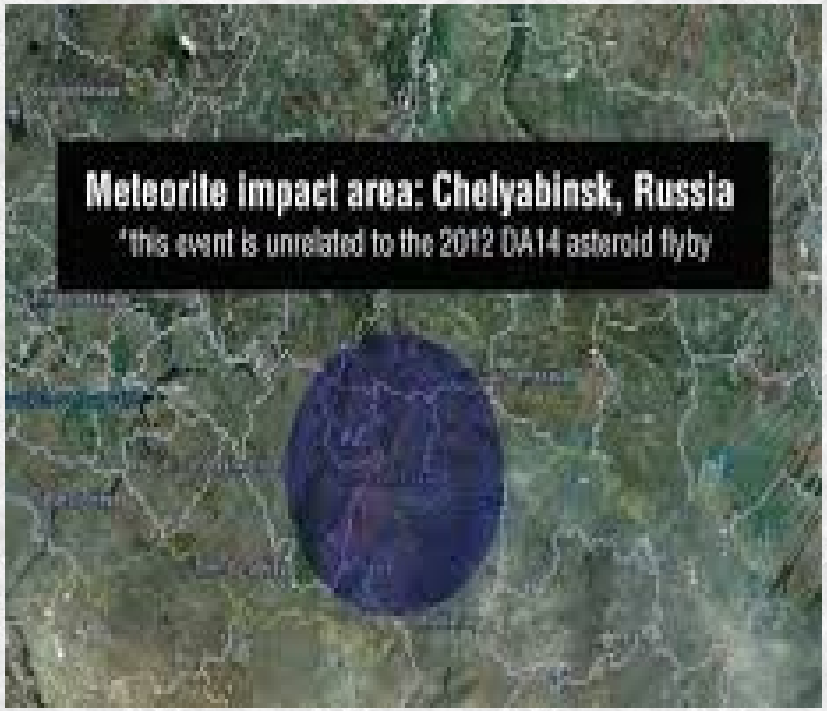
Human-”impact” stories

---

and other space hazards

Impacts and Near-Impacts

D1.1. 1.2, 2.3, 3.2, 3.3, 3.5



Front-page news Feb. 15+

- Always a newsworthy topic, for obvious reasons
- Lots of Canadian expertise
- And students can do experiments with impacts

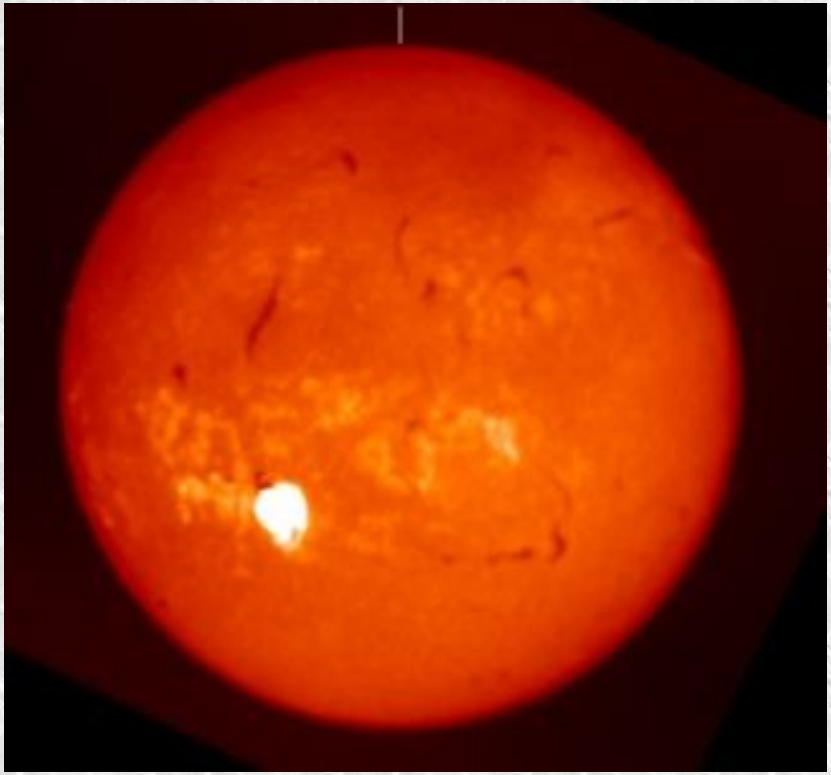
Satellite Re-entry

News reports Nov. 11

- This, space debris, and light pollution are excellent STSE topics for student debate and discussion
- November 10: ESA GOCE satellite reenters; no damage done

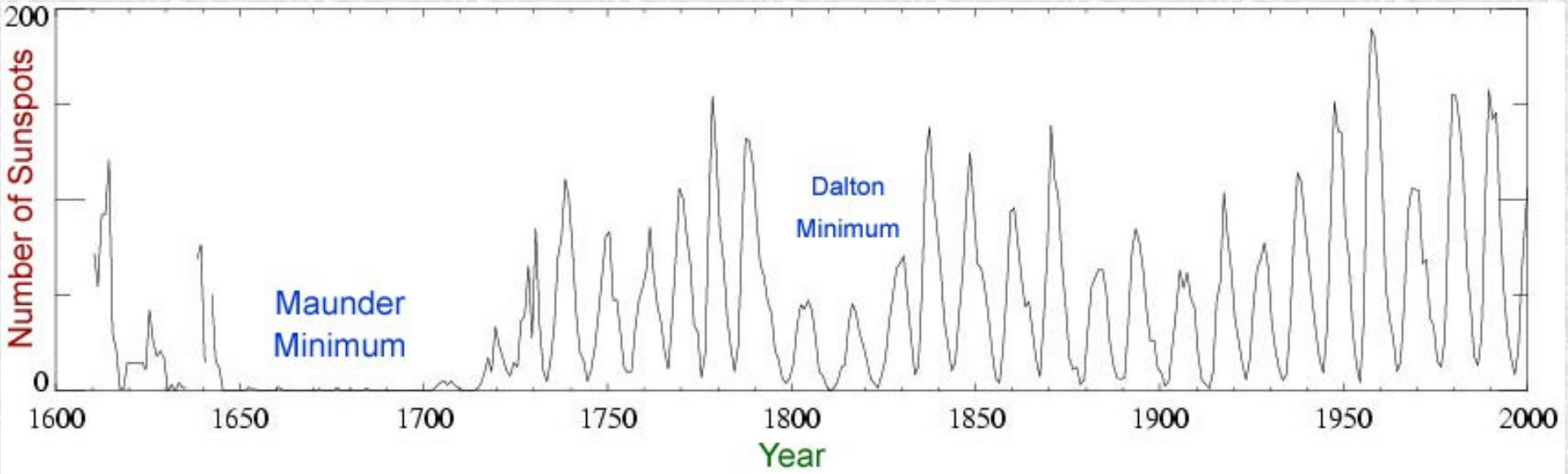
Solar Flares and Auroras

Solar flares are bursts of radiation and particles which can affect spacewalkers, satellites, and the upper atmosphere in a significant way -- “space weather” (D1.1, 1.2, 2.2, 3.4, 3.5)



Sunspots and Climate Change?

Your students can observe, measure, and/or graph sunspots, and investigate the hypothesis that they have some connection with recent climate change. Observe the sun safely! (D1.2, 2.2, 2.4, 3.4, 3.5)

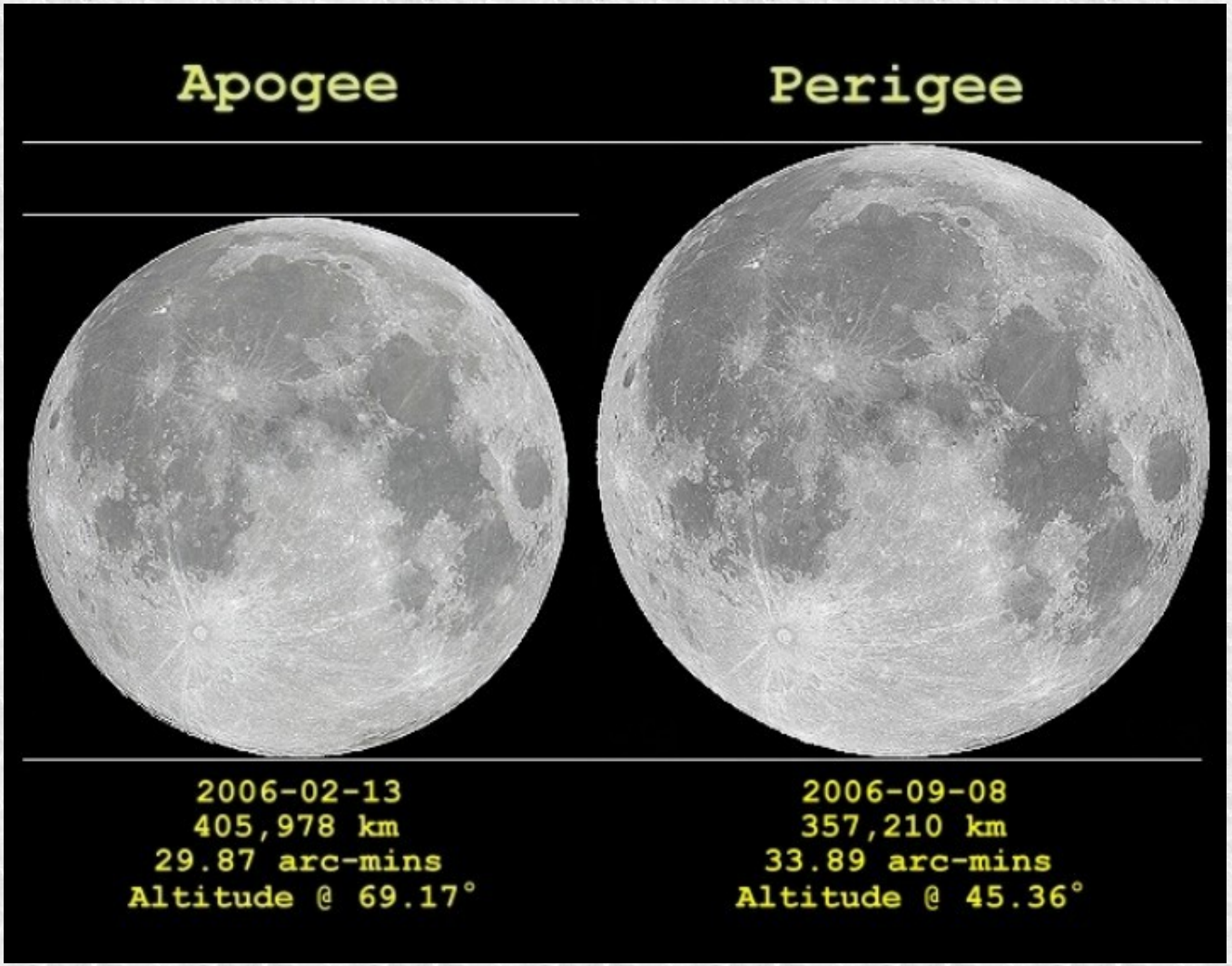


Offbeat Topics

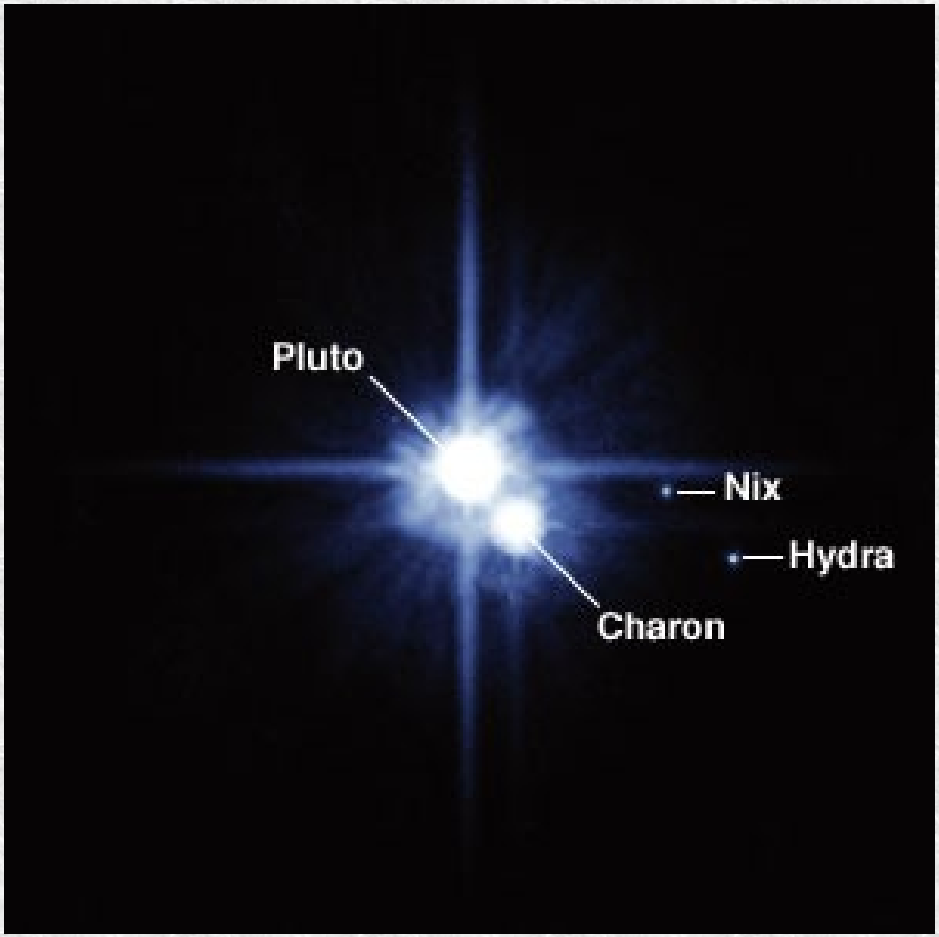
The media seize on things that sound unusual, even if they have little or no scientific significance

Supermoon! (D2.2, 2.5, 3.5)

The (apparently) biggest moon of the year



The Demotion of Pluto
D2.1, 2.4, 2.5, 3.2)



- A necessary action; Pluto is very small, and there are similar and larger objects out there!
- A good topic for debate ...
- ... and discussion of the outer solar system

Taxpayer-Interest Stories

In Canada, most basic science is funded by governments

What You Should Hear About

James Webb Space Telescope (left)

Thirty-Metre Telescope (right)

Cost!/Benefit? D1.1, 1.2

What You Should Also Hear About Atacama Large Millimetre Array (ALMA)

NRAO

- Largest radio telescope
- High Atacama desert, Chile
- Probes the universe at millimetre wavelengths
- Canada is a partner, based on its expertise in radio astronomy

What You Should Also Hear About: Canada's “Humble Space Telescope” (D1.1, 1.2)

- Microsatellite
- Most precise light-measuring device
- A few million $$$
- Functioning way past its “shelf life”
- Uses a novel stabilizing mechanism developed by Canadian industry

What You May Not Hear About (But Should)

BRITE nanosatellite (left)

BLAST balloon mission and others (right)

Two-page spread in the
Globe and Mail Feb. 25

Space Tourism!

Toronto Star Nov. 9

- World View Enterprises plans to lift tourists to 30 km altitude, using similar balloon; cost $75,000
- This and sub-orbital space flight: excellent topics for student investigation, discussion, debate

Sky Phenomena

Observable (or not)

- Meteor showers (usually not observable)

- Eclipses of the sun or moon (usually not observable here)

- Offbeat things

- UFOs

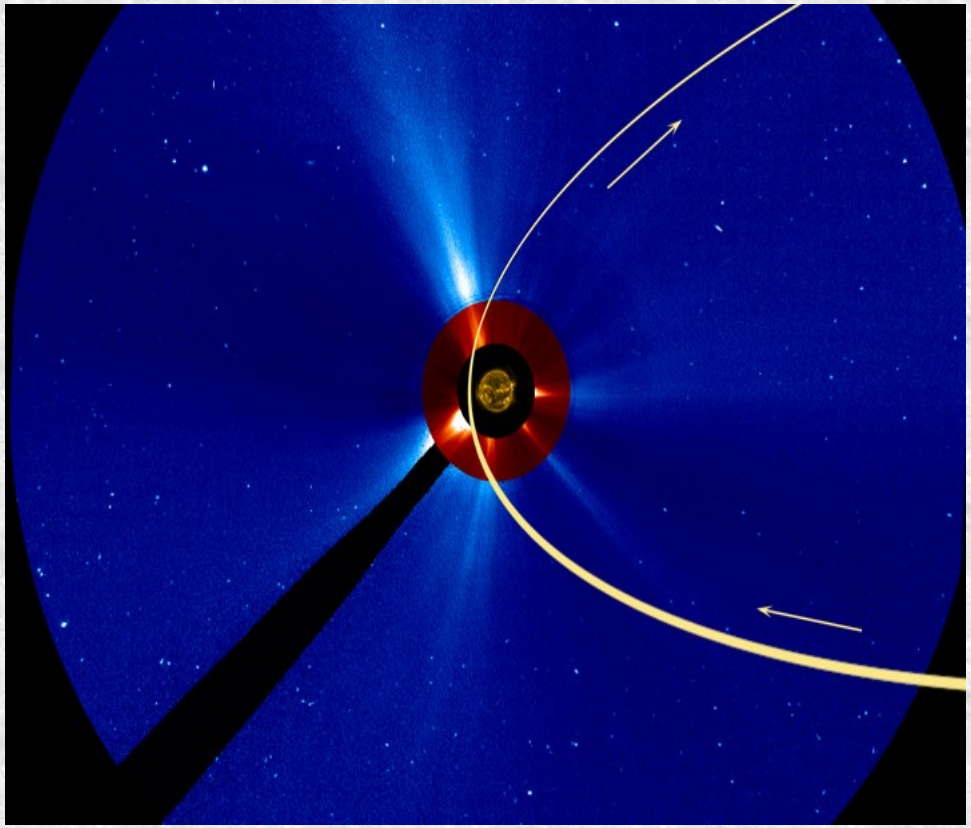
Multiple coverage Nov. 3-10

Comet ISON

The biggest astronomy story (or flop) of late 2013

But see it if you can!

ISON's Orbit: Sungrazer!



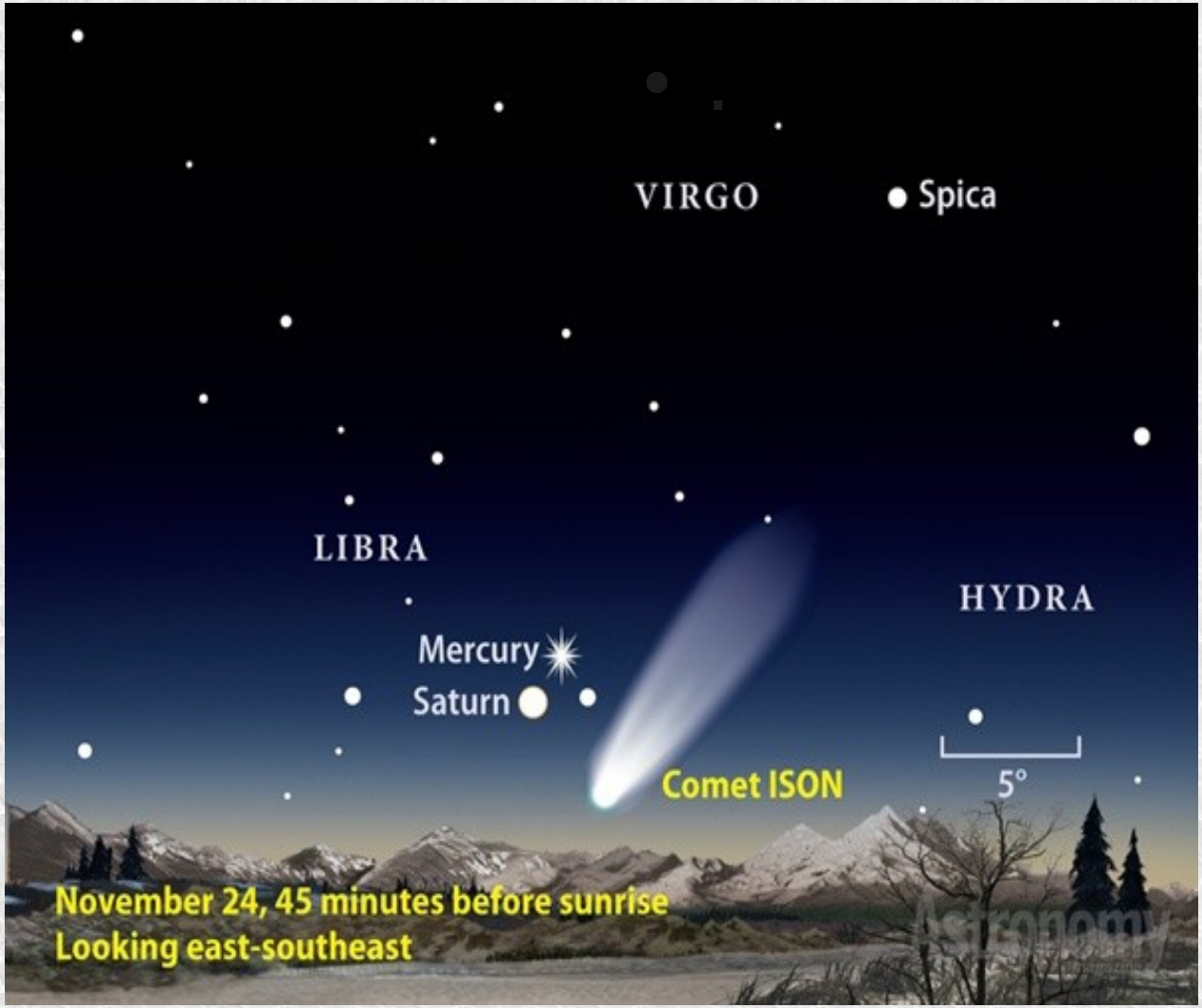
- Probably making its first visit to the inner solar system
- How volatile is its surface?
- Will it survive a near-collision with the sun?

Comet ISON November 6, 2013

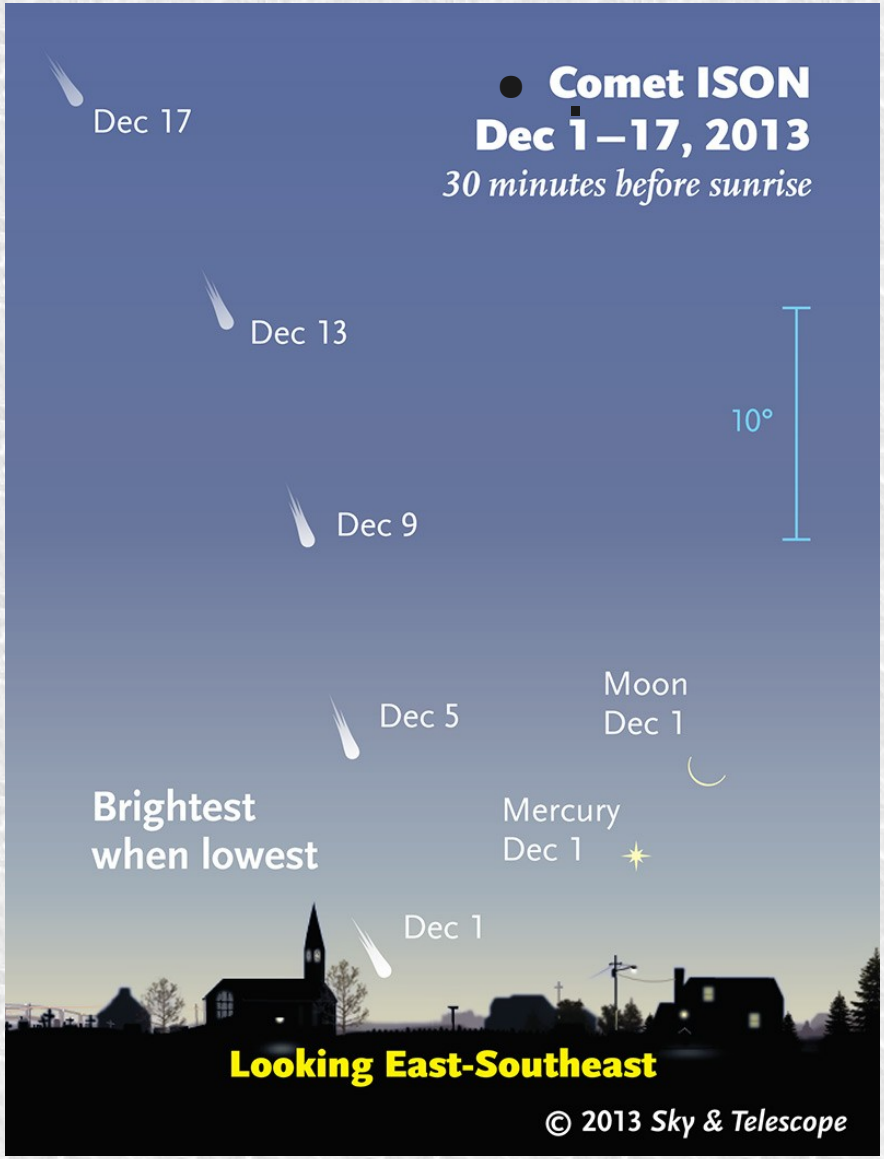
image by Damian Peach

It's there, but faint

ISON in November (maybe)



ISON in December (maybe)



Big, Ideas

Prime Areas of Frontier Research

SNC1D: Page 47

Big Idea: Astronomy Is an Observational Science (D2.2)

One of the Gemini telescopes

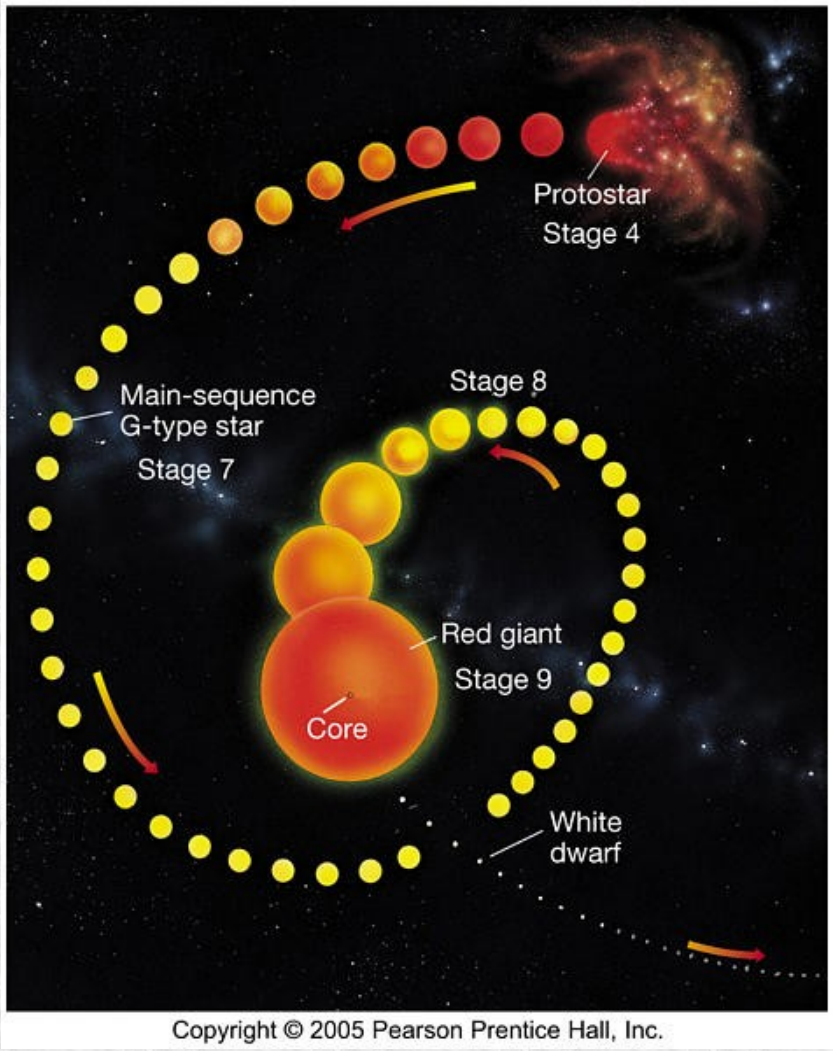
- Need for telescopes: gather light, see detail
- Cost/benefit
- Link with optics
- Facilities for many wavelengths
- Canadian facilities
- Not just Hubble

Big Idea: Planets and Moons are Other Worlds (D3.3)

Curiosity at Mars

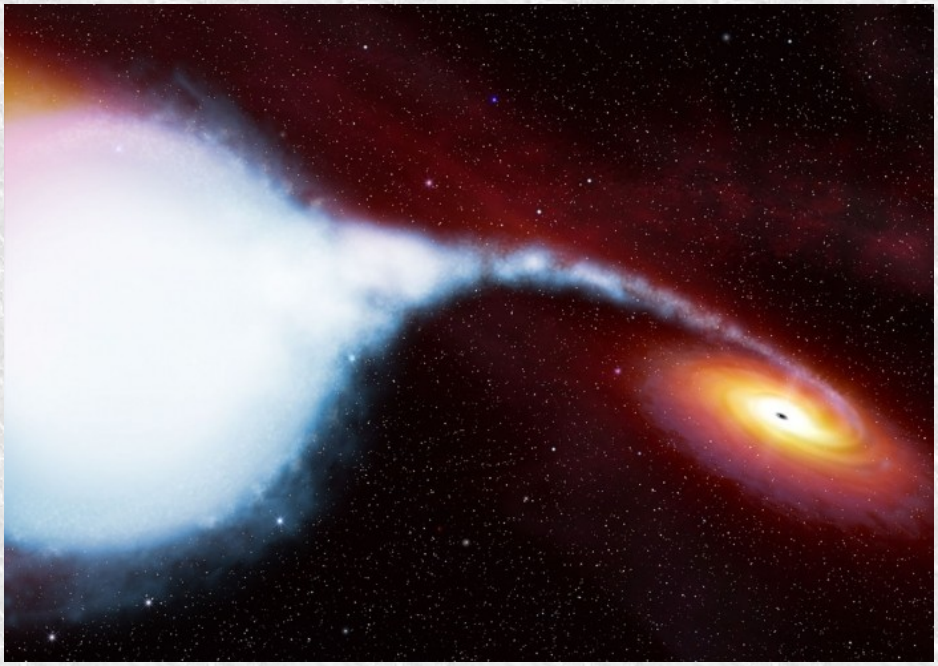
- Space exploration
- Debate: manned or unmanned?
- Comparative planetology
- Are/were these worlds life-bearing?

Big Idea: The Sun is a Star; Stars Have Life Cycles (D3.4, D3.2)



- Past, present, and future of sun
- Why there are stars of many kinds
- Stardeath!
- White dwarf: density 1 tonne/cm^3
- Neutron star: density: millions of tonnes/cm^3

Big Idea: Stars End Up in Bizarre Forms: White Dwarfs, Neutron Stars, Black Holes



Artist's conception of Cygnus-1, A binary system containing a black hole

- Exciting – especially black holes
- How are these objects found and studied?
- First black hole was discovered at the Dunlap Observatory

Big Idea: There Are Planets Around Other Stars – Maybe Other Earths (D3.2)

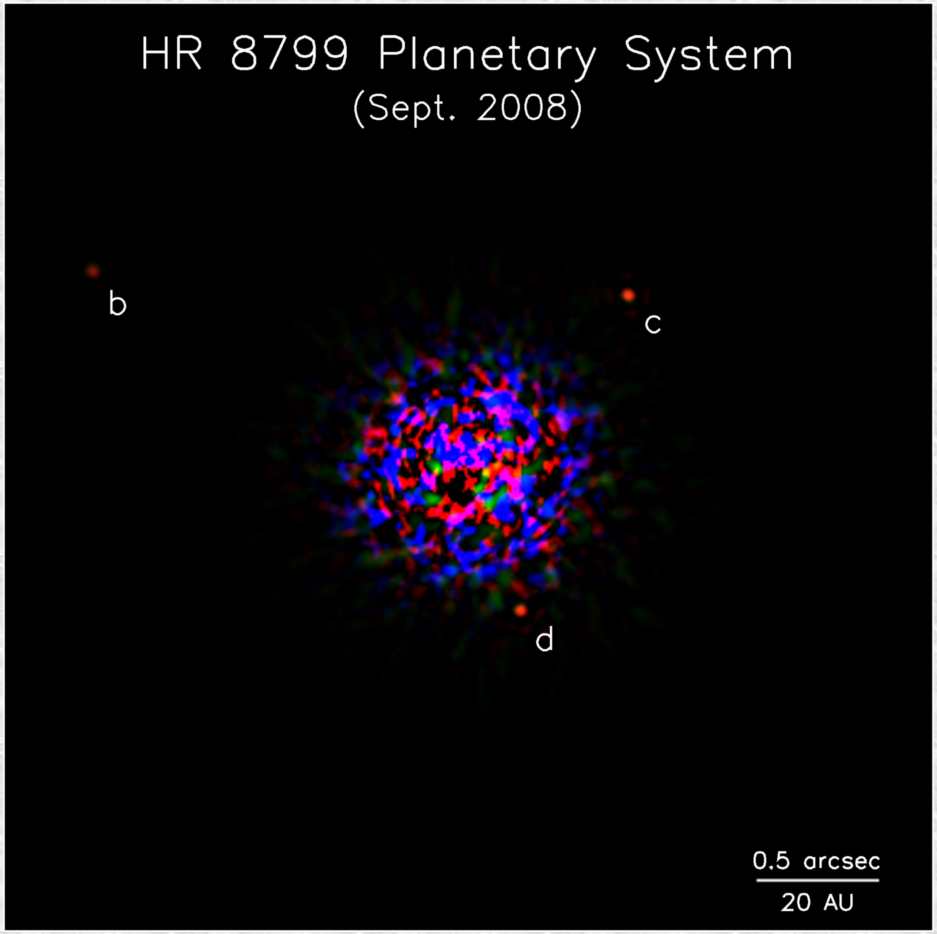
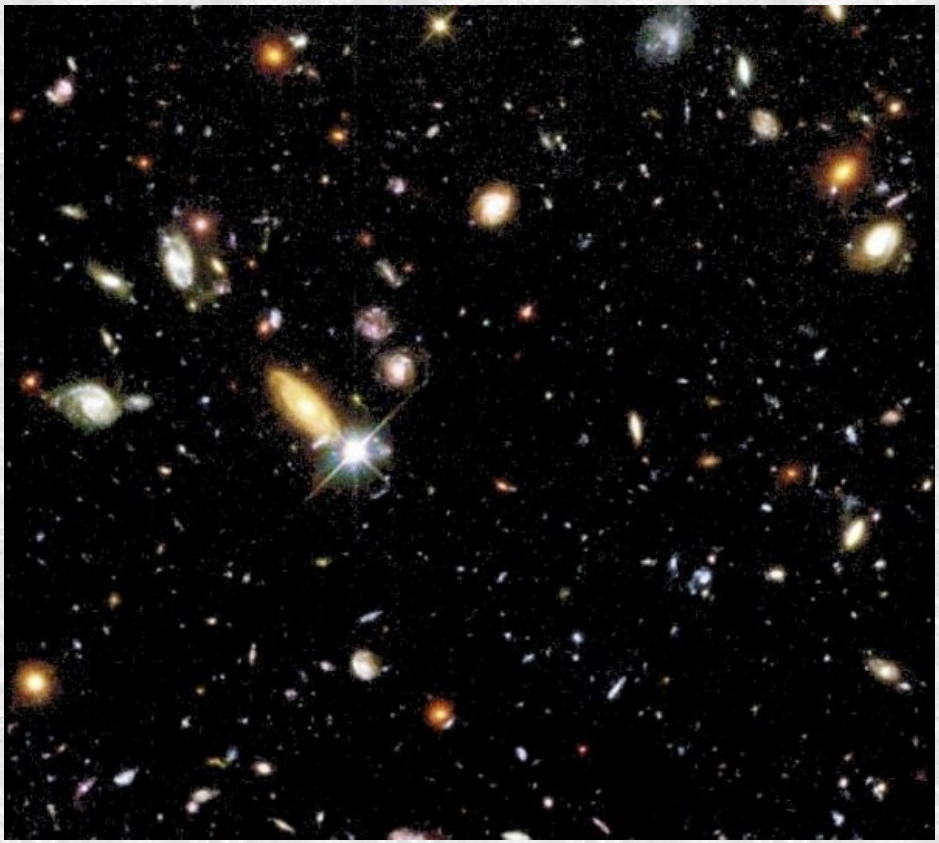


Image of an exoplanet system;
National Research Council Canada

- Canadians are leaders in all aspects of this field
- Super-earths!
- Free-range planets!
- How are they found and studied?
- Atmospheres?
- Life-bearing?

Big Idea: Astronomers can look backward in time by looking outward in space (D3.1)



The Hubble Deep Field, a tiny fraction of the whole sky

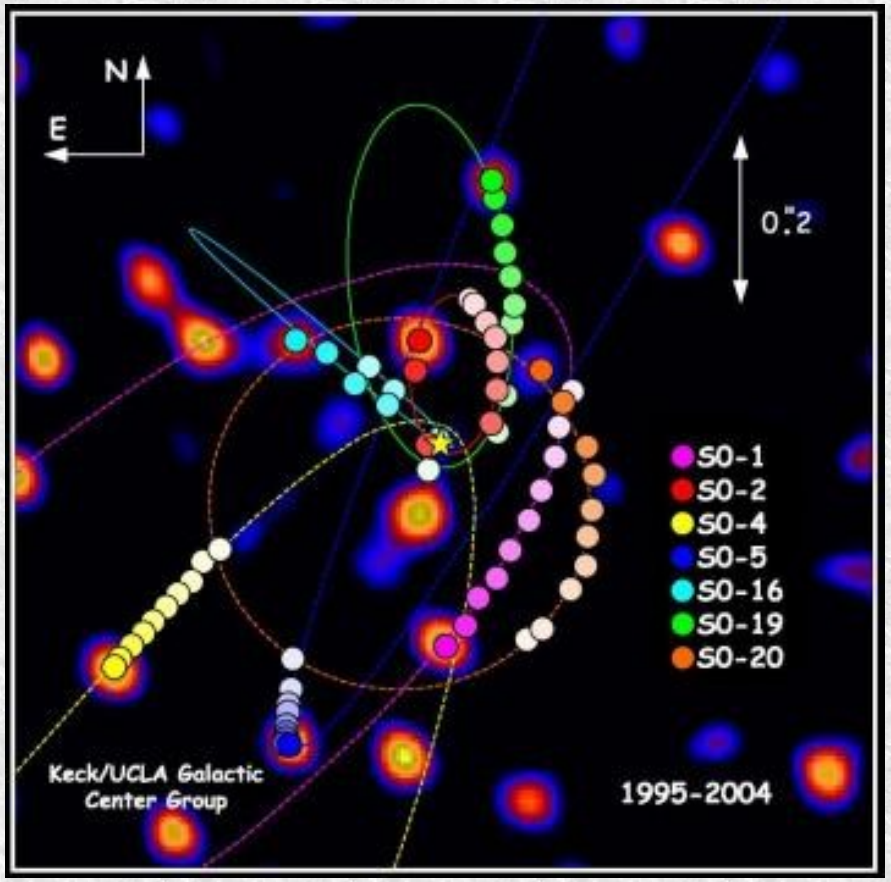
- The smallest, faintest points of light on this image are galaxies of hundreds of billions of stars, so far away that their light has taken up to 10 billion years to reach us; we see them as they were, 10 billion years ago.

Big Idea: Most of the Mass of the Universe is Invisible "Dark Matter" (D3.1, D3.3)

Simulated map of the dark matter around our Milky Way galaxy.

- What is "matter"?
- What is "dark" matter?
- How can we find out?
- How is it found and studied?

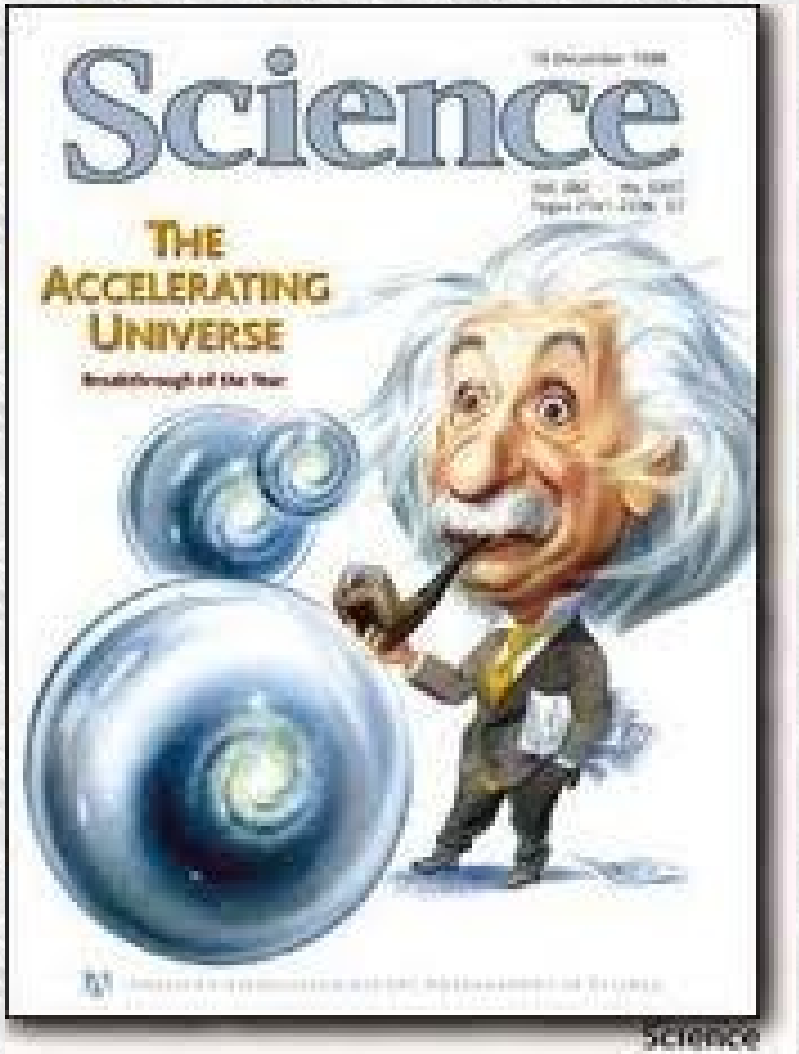
Big Idea: Galaxies Have Supermassive Black Holes at their Centres (D3.1, D3.3, D3.5)



The observed motions of stars
Near the centre of our galaxy

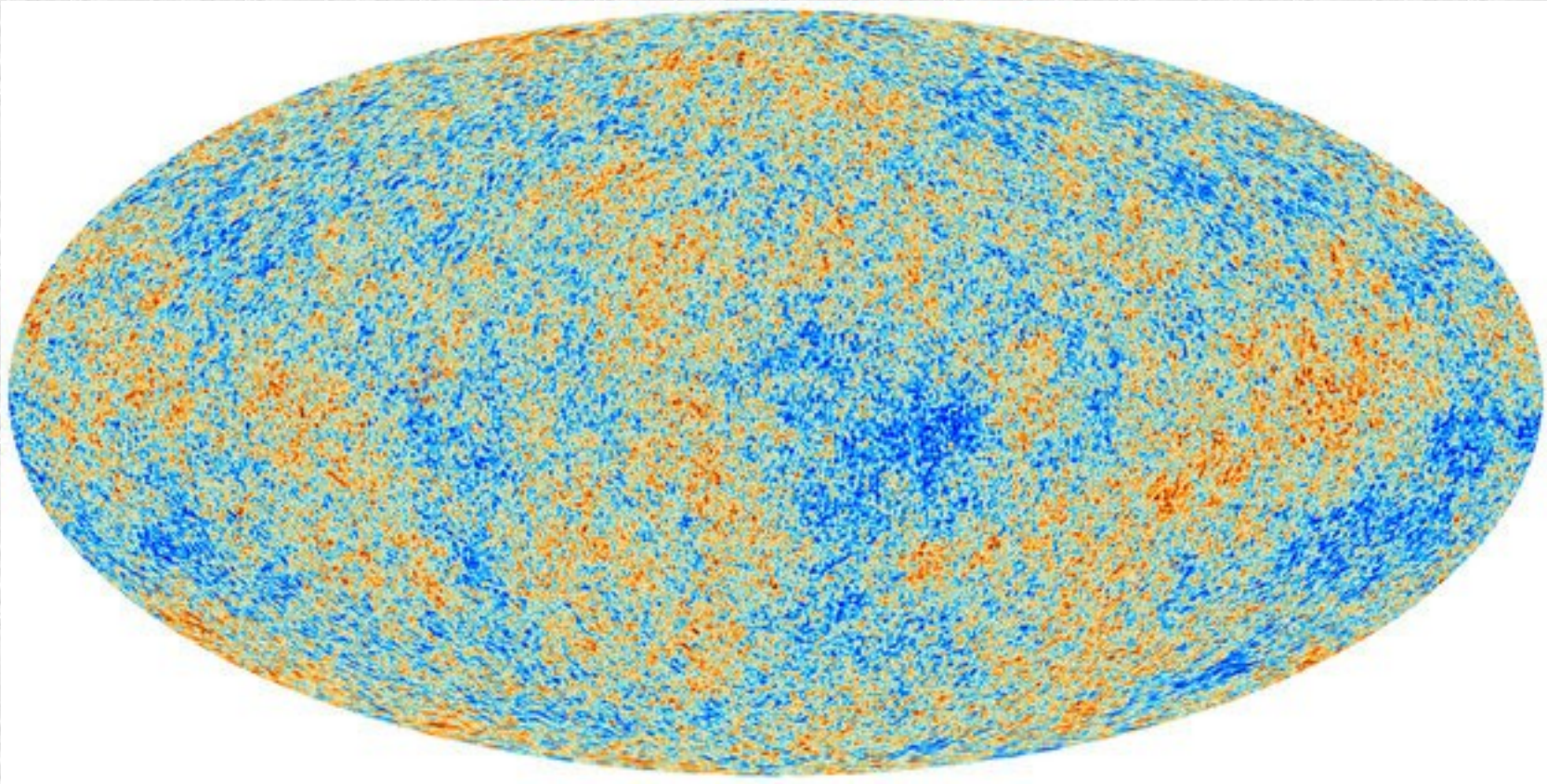
- How are they found and studied? (Kepler's and Newton's Laws!)
- How and when did they form?

Big Idea: The Universe is Expanding from its Birth at an Accelerating Rate (D3.1, 3.3, 3.5)



- What is “energy”?
- What is “dark” energy?
- How is it found and studied?
- What does it say about the future of the universe?

Big Idea: We Can See the Leftover Radiation from the Birth of the Universe (D3.1)



The universe at 400,000 years old, courtest of the Planck satellite

THE FAR SIDE By GARY LARSON

"Mr. Osborne, may I be excused? My brain is full."

www.astro.utoronto.ca/~percy/EPOindex.htm