Toronto's Astronomical Heritage

and how it connects with the growth of our city and our country

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and

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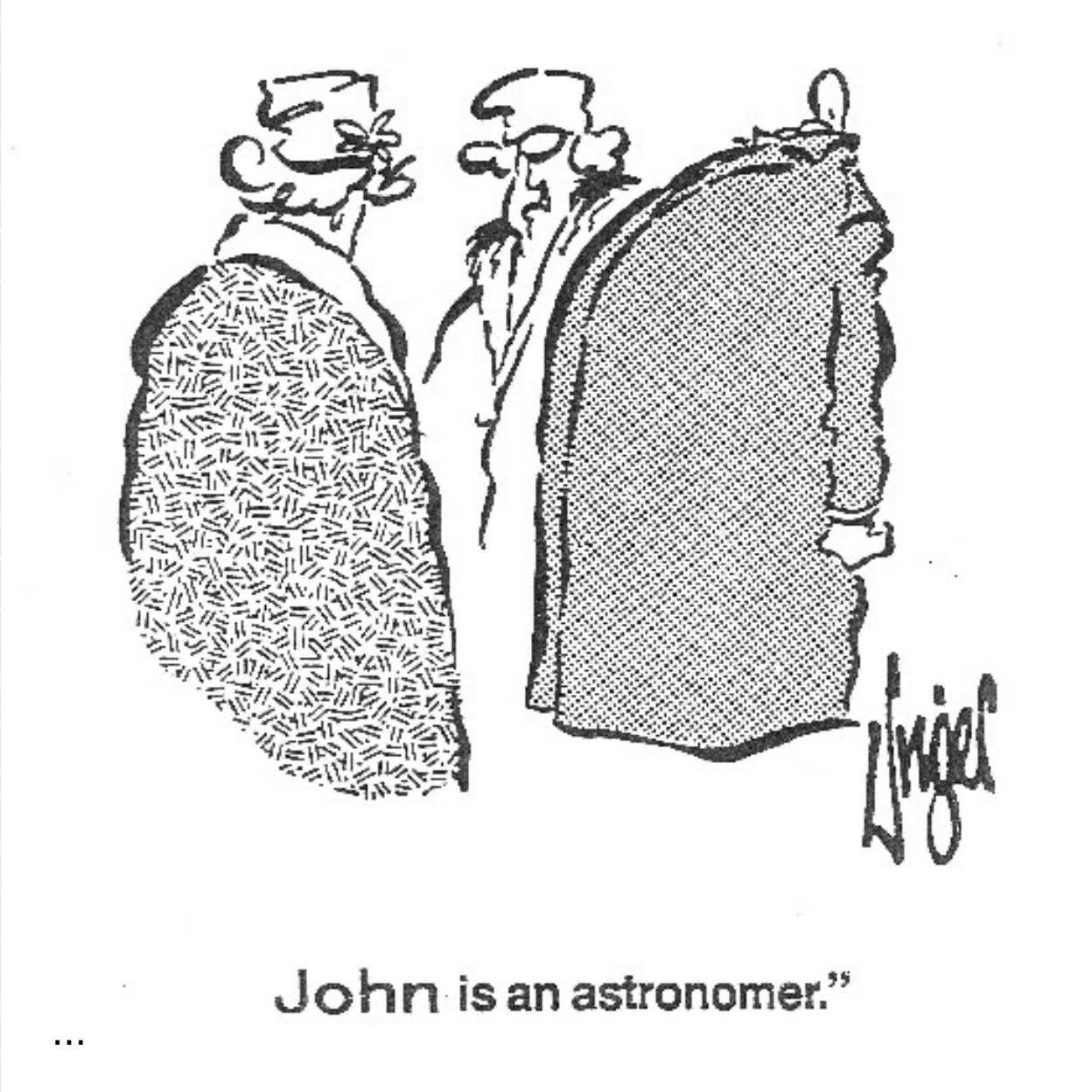
Full disclosure: I am an astronomer, not a historian



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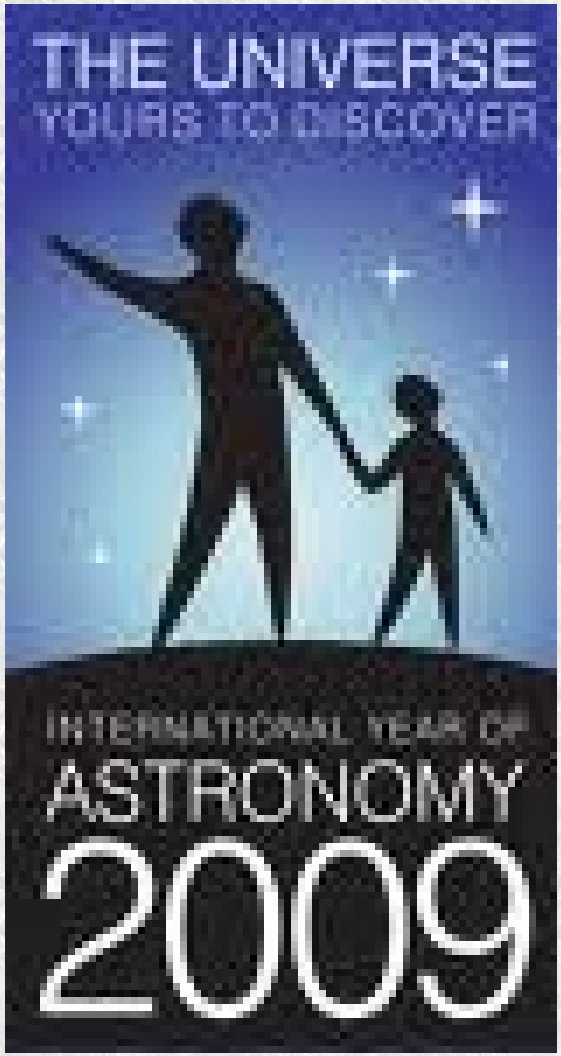
The Origin of this Presentation

International Year of Astronomy 2009

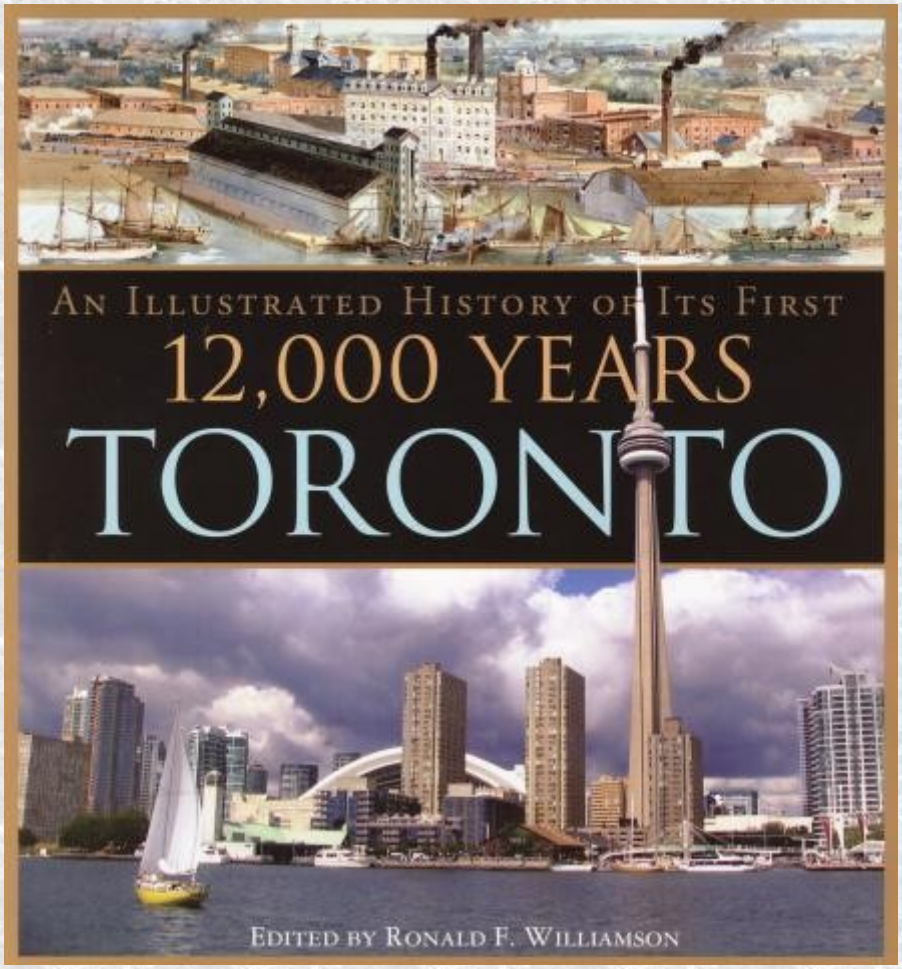
in partnership with Heritage Toronto



- A 148-country celebration of the 400th anniversary of Galileo's development and first use of the astronomical telescope
- In Canada: over 3,600 events reaching almost two million people

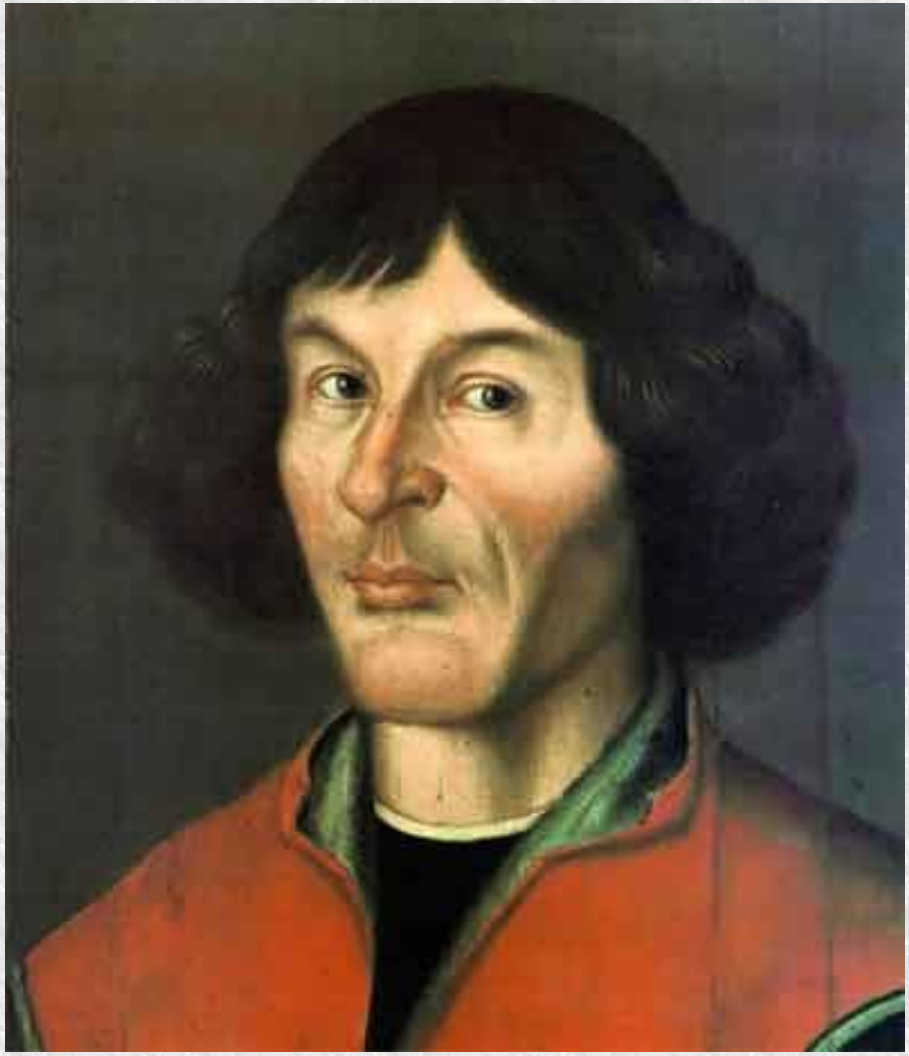
Aboriginal Astronomy

Canada's Aboriginal people have used the sky as a clock, calendar, and compass for centuries, and made the sky part of their spirituality



Copernican Revolution (1543-1687)

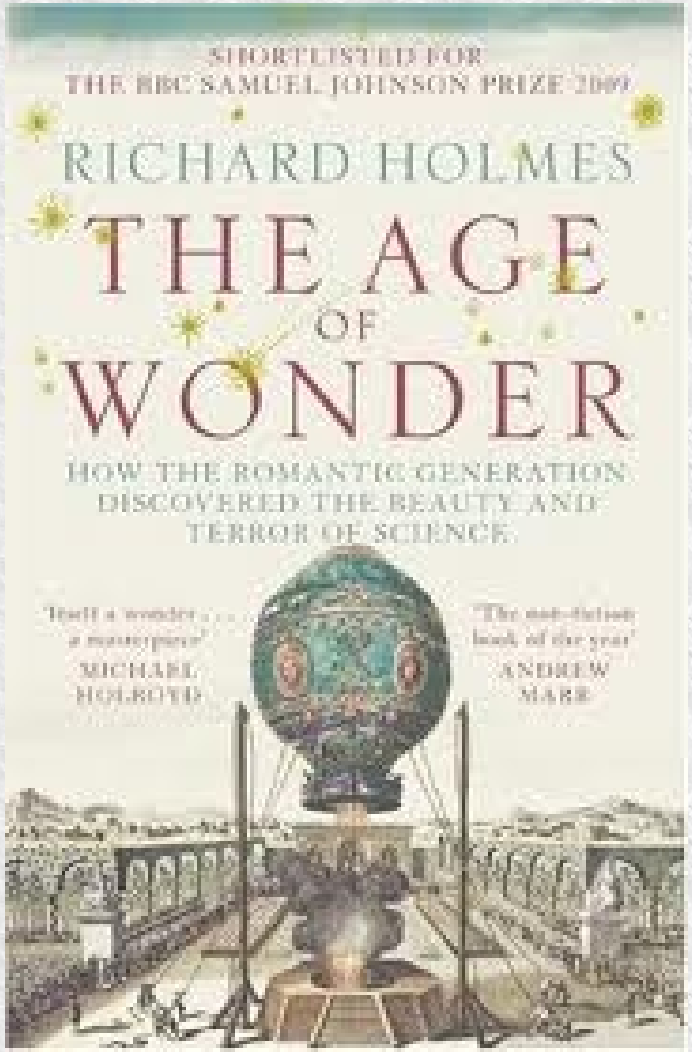
took place in Europe



Nicolaus Copernicus

- Sun-centered model (Nicolaus Copernicus); empirical proof (Galileo Galilei); better planetary positions (Tycho Brahe); better planetary orbit theory (Johannes Kepler); laws of motion and of gravitation (Isaac Newton)

18th Century Science -- in Europe



- Major advances in astronomy (William Herschel) and the other sciences
- Closer connections between science, the humanities, and the arts (Coleridge, Shelley)
- Rise of public lectures, demonstrations, museums

Richard Holmes, *The Age of Wonder*

York/Toronto in 1800-1850

- Became capital of Upper Canada in 1793
- War of 1812
- Population: 720 in 1812; 31,775 in 1851
- Town of York becomes City of Toronto in 1834
- Upper and Lower Canada join in 1841; subdivided into Canada East and Canada West
- U of T chartered in 1827; opened in mid-1850's
- **Industry, merchandising, banking and transportation blossom 1850+**

The British Admiralty's Magnetic Observatory (1840)

On present-day U of T campus

- This was part of an international project to understand why compass needles “wandered” on time scales of hours to years – very important!
- When the cause (earth-sun relations) was known, the results were published, and the observatory was dismantled

Toronto Magnetic and Meteorological Observatory (TMMO: 1853-1908)

- When the Admiralty observatory was dismantled, the colonial government wisely decided to build a new and better observatory
- This was the official centre for meteorology and practical astronomy, including timekeeping, for Canada

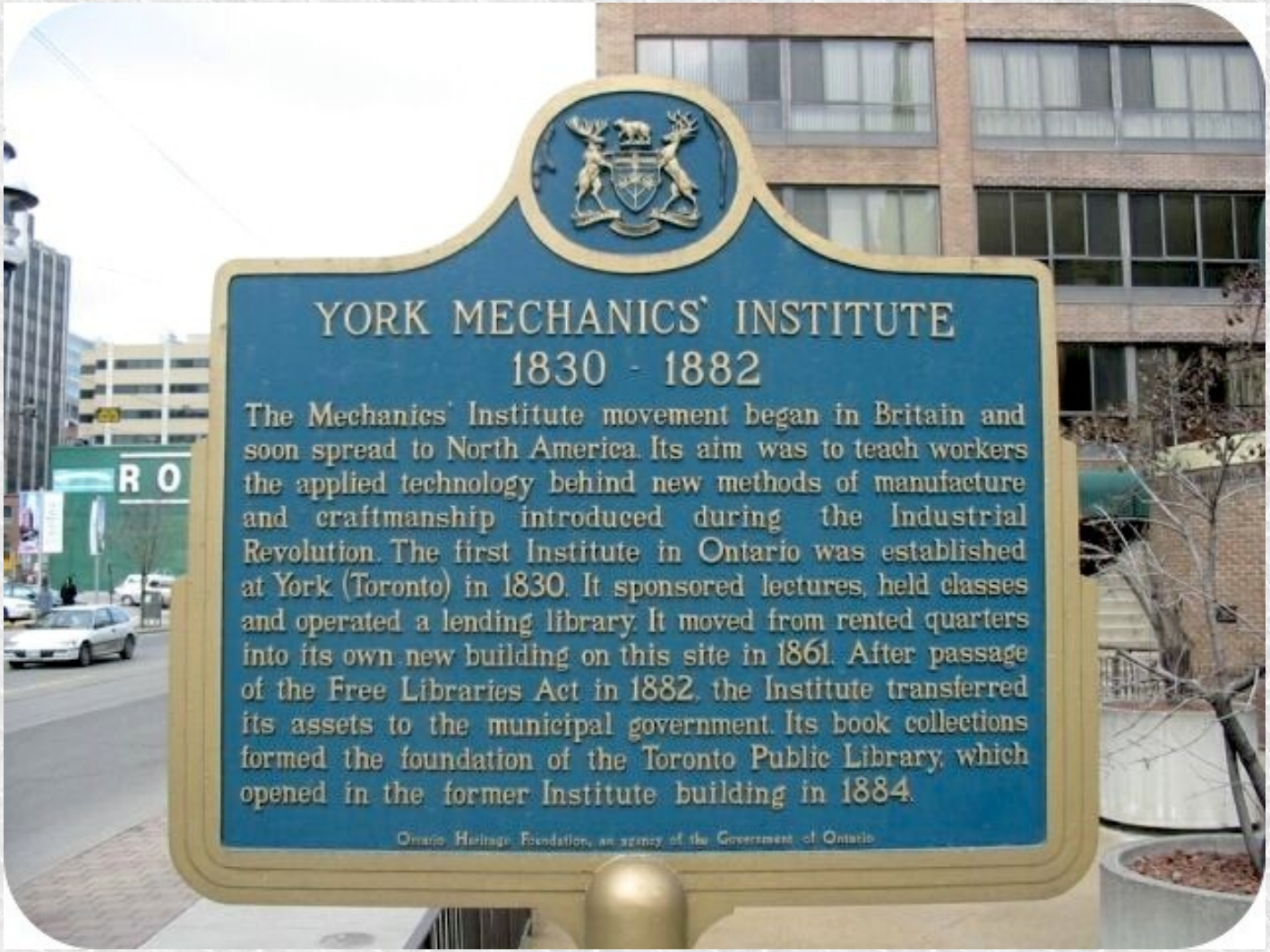
Astronomy and Surveying

official position of Toronto for surveying and timekeeping

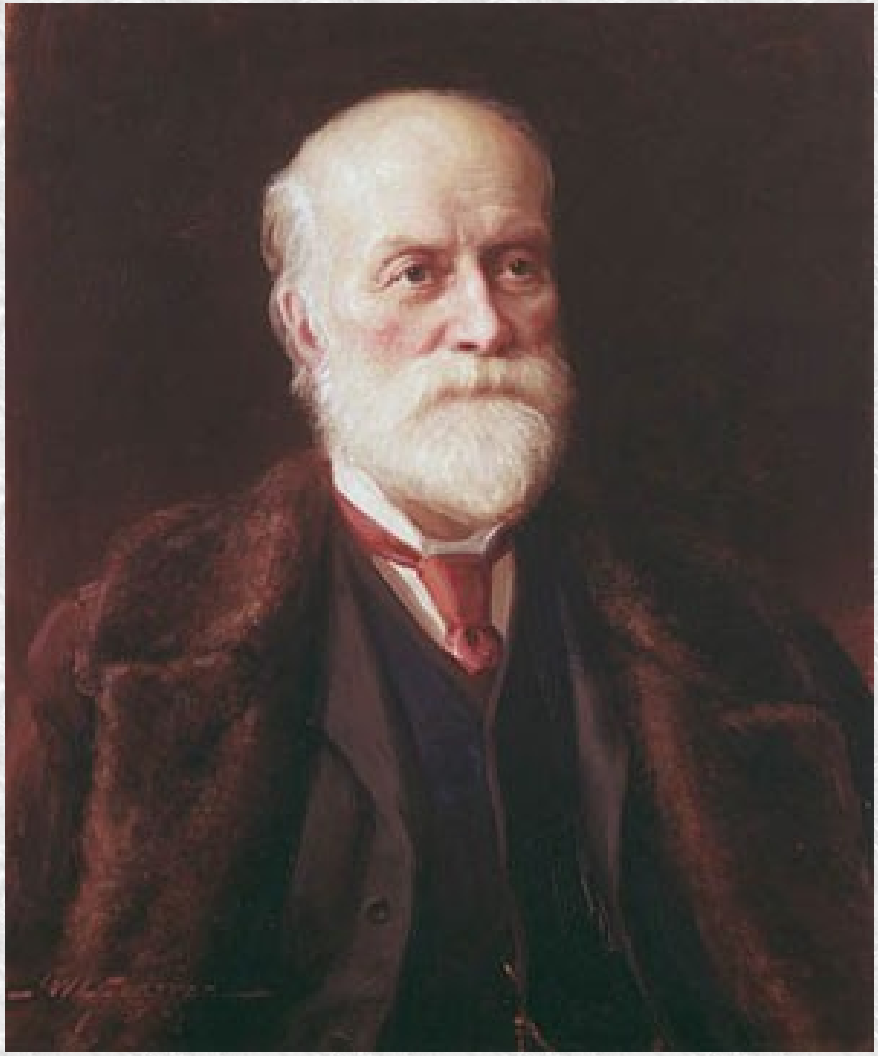
- Latitude fundamentally determined from the angle of stars above the horizon
- Longitude fundamentally determined from the time of passage of stars across the N-S line
- Time known by telegraph
- Surveying could then be done relative to a known reference point (e.g. left)

Public Interest in Science/Astronomy

York/Toronto Mechanics Institute



Sir Sandford Fleming (1827-1915)



- Engineer, surveyor, mapmaker, railway builder and entrepreneur
- Most vocal and successful proponent of Standard Time (1880's+)
- Developed Canada's first postage stamp (1851)
- Co-founded the Royal Society of Canada (1882), and the Royal Canadian Institute (1849)

The Royal Canadian Institute

- In the 19th century, science was developing as both an important tool for society, and as a topic for communication and discussion; development of “Mechanics Institutes”
- The Royal Canadian Institute was founded in 1849, and is **Canada's oldest scientific society**
- Major player in science in Canada in late 19th century

Toronto Astronomical Club

Andrew Elvins, driving force

- In 1868, a group of eight “laymen” gathered to discuss practical and general astronomy
- The group slowly grew changed names, and attracted some professional scientists
- By 1890, it became the basis for the **Royal Astronomical Society of Canada**

Royal Astronomical Society of Canada

- An organization of 5,000+ mostly amateur astronomers, in 29 centres across Canada, and members beyond
- 2003 recipient of the *Michael Smith Award* for excellence in science outreach
- Variety of activities and publications of interest to amateur astronomers of all kinds

Founding the University of Toronto

- Charter in 1827, but disagreement over whether it should be Anglican or secular
- Angicans established Trinity College separately
- University College was established in 1853 (in temporary quarters), built in 1859, burned in 1890 and rebuilt

Victoria College

and the beginning of teaching astronomy at U of T

“Old Vic”

- One of several theological colleges which affiliated with the University of Toronto in the late 1800's.
- First located in Cobourg; (1842), then affiliated with the University of Toronto in 1892

Egerton Ryerson (1803-1882)

- Founding President of Victoria College (1841)
- Developed public education system in Ontario, starting in 1844
- He founded a series of institutions at St. James Square which later evolved into universities, museums, and research facilities

“Surely the knowledge of the laws of the universe, and the works of God, is of more practical advantage, socially and morally, than the knowledge of Greek and Latin”. -- Egerton Ryerson, 1842

History and Philosophy of Science

- The University of Toronto Institute for the History and Philosophy of Science and Technology (IHPST) is housed at “Old Vic”
- Since IYA 2009, it has co-sponsored astronomy activities: lectures and exhibits

U of T Scientific Instrument Collection

www.utsic.org

1830 Gregorian telescope

- A project of graduate students in IHPST
- Dedicated to cataloguing and conserving the University's scientific instrument collection
- A “virtual” museum
- Astronomical instruments were catalogued in 2012 as a “Transit of Venus” project

Transits of Venus

- Rare passage of Venus across the face of the sun
- Historically important for determining the scale of the solar system
- Observed most recently in 1874, 1882, 2004 and 2012
- The TMMO purchased a telescope to observe the 1882 transit (it was cloudy)

Clarence A. Chant (1865-1956; UC 1890)

Co-father of astronomy in Canada

- Joined the Physics Department in 1891-2
- Taught Astronomy; established Astronomy Department in 1905, with courses and programs
- Wrote and lectured extensively; led to Dunlap Observatory
- Guiding light for the RASC for 50+ years

UC Lit (and Sci) 1888-9

Chant is in the top row, at the right

University College Literary and Scientific Society

GENERAL COMMITTEE, 1888-9

Growth of Astronomy at U of T

Chant joined the Department of Physics in 1892 and subsequently...

Established a separate budget for astronomy

Created courses and labs in astronomy

Created a Department of Astronomy

Campaigned for a major telescope

U of T at the Turn of the Century

- Independent denominational colleges (St. Michael's 1881, Trinity 1904, Victoria 1892 ...) affiliate with the non-denominational University
- Professional schools (Education 1907, Engineering 1906, Medicine 1887 ...) affiliate with the University
- The University assumes responsibility for teaching laboratory sciences for these colleges and faculties
- New buildings and instruction needed!

Physics Building 1907

- One of several buildings erected near the site of the TMMO to teach the sciences; astronomy housed here
- Burned and rebuilt (as the Sandford Fleming Building) in 1977; now Electrical Engineering
- Convocation Hall was also built adjacent to TMMO

The Observatory Moves (Slightly)

The Stewart Observatory

- The TMMO was to be demolished, but Surveying Lecturer Louis B. Stewart arranges for it to be disassembled and re-erected in its present site, a short distance away, in 1907-8
- Subsequently used for surveying; now the headquarters of U of T Student Union

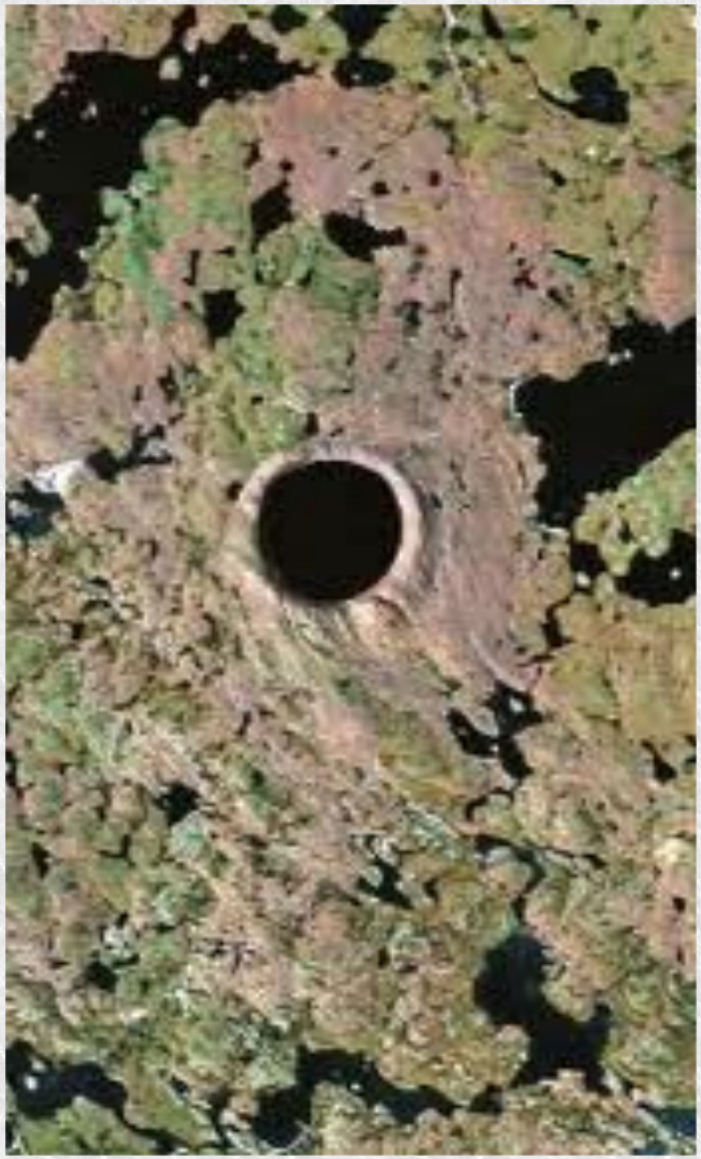
Meteorological Office Moves North

- Canada's meteorological headquarters moves to 315 Bloor Street (now part of the Munk Centre): beautifully repurposed 2013
- Moved to Dufferin and Steeles in 1971
- Note the small building for the “transit telescope” on the west side (left)

The Royal Ontario Museum

- Opened 1914; building on the work of the Royal Canadian Institute and of Egerton Ryerson
- Hosted McLaughlin Planetarium; still have an active astronomy education program with portable planetariums
- Meteorite collection, forthcoming “Gallery of Early Life”

Meteorite Impact Craters



- 1950: prospector Fred Chubb informs ROM geologist V.B. Meen of an unusual 3.4 km lake in northern Quebec
- The ROM mounts expeditions to explore it, the second sponsored by the *National Geographic Society* – lots of publicity
- Canadian scientists have become experts on meteorite craters

ROM's Meteorite Collection

Carbonaceous chondrite

- Meteorites are stones from space; most are pieces of asteroids
- A rare few are left over from the birth of the solar system, 4.5 billion years ago
- The ROM, in its mineralogy gallery, has one of the world's best collections of the rare meteorites

David Dunlap Observatory

future uncertain

- A result of Chant's public outreach: mining lawyer David Dunlap expresses a strong interest in Chant's proposal for an observatory
- After his death, his widow Jessie donates the funding to the University; it houses the second-largest telescope in the world

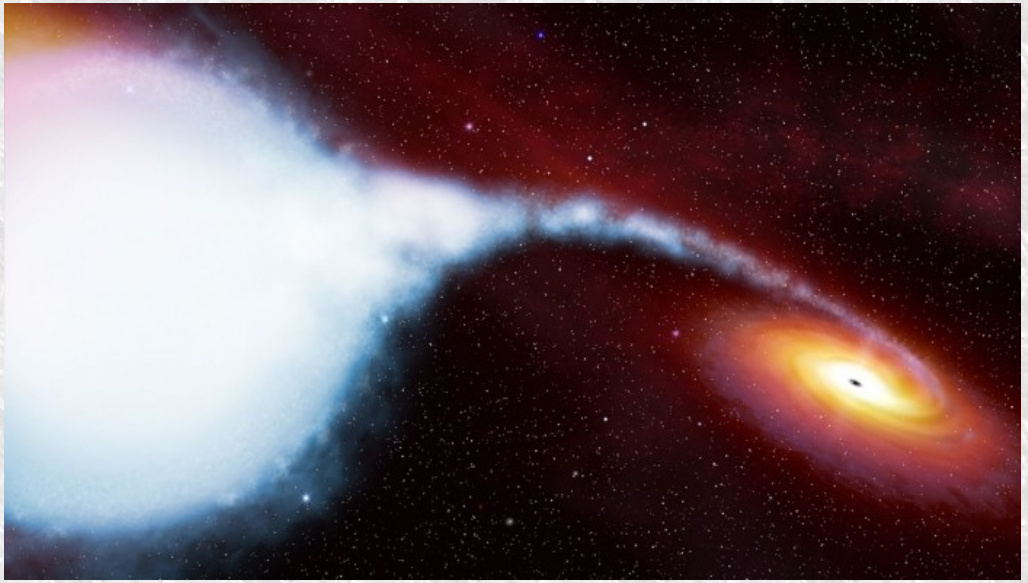
David Dunlap Observatory

future uncertain

- Research, student training, public education
- Research-active until 1980's; **discovery of first black hole in space** in 1971-2
- Use declined; lands sold to a developer in 2008; proceeds endowed Dunlap Institute
- Active in public education, until this year

1972: Discovery of the First Black Hole

Professor Tom Bolton
University of Toronto



Helen Sawyer Hogg (1905-1993)

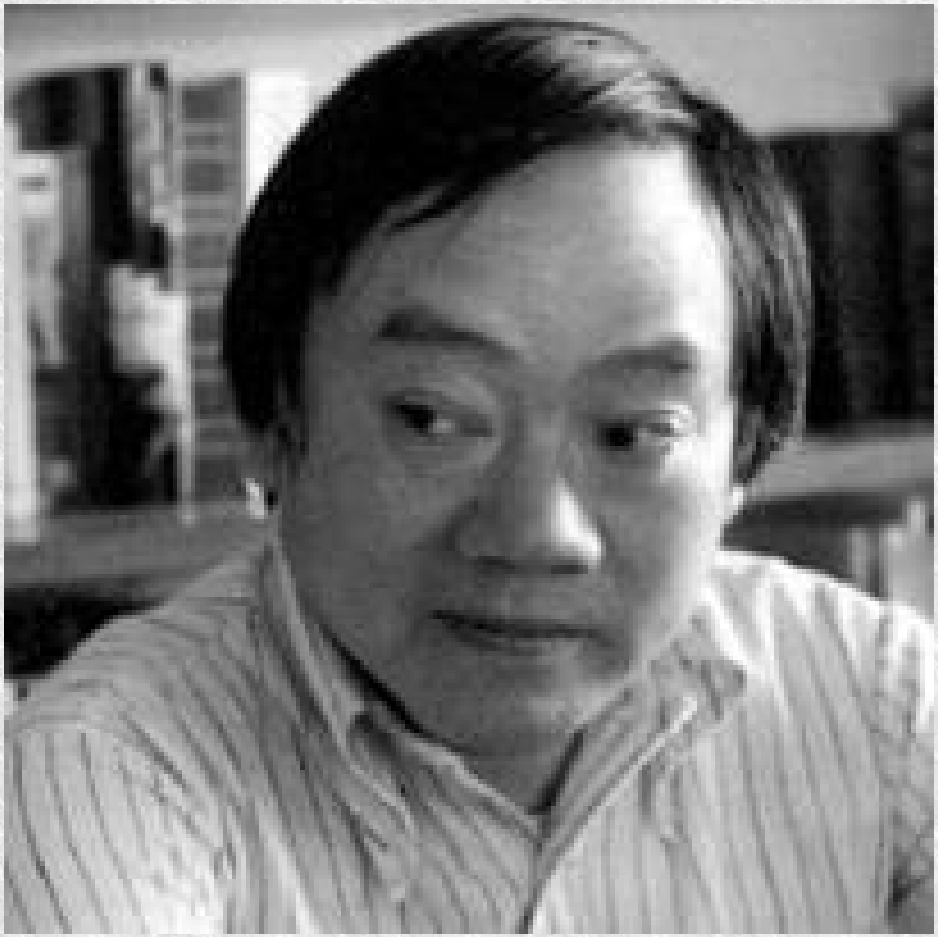
Canada's best-known and most beloved astronomer

- Arrives 1935 with her astronomer husband Frank (who passes away in 1951)
- Eminent researcher, teacher, administrator, pioneer woman physical scientist: CC, FRSC etc.
- Wrote a weekly astronomy column in the *Toronto Star* for over 30 years; author, lecturer, TV host

Post-War Developments

- Thousands of servicemen are offered free university education; many choose engineering
- Consequent expansion of engineering facilities
- Development of aviation and electronics technologies after WWII (including at U of T)
- Further expansion of science and engineering after Sputnik and the Cold War
- Post-war “baby boom” results in expansion of the school system in the 1950's and of the university system in the 1960's

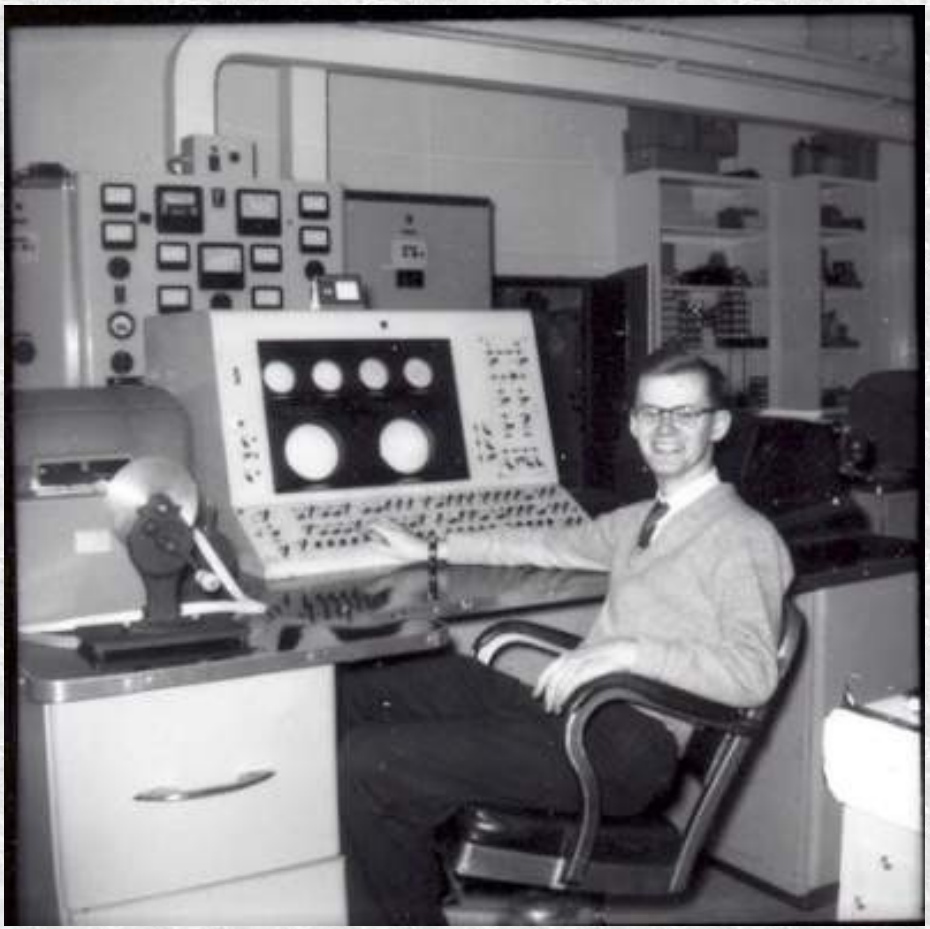
Radio Engineering and Astronomy



Allen Yen

- Building on WWII radar technology, and the discovery of cosmic radio radiation, radio astronomy becomes a new frontier
- At the University of Toronto, electrical engineer Allen Yen collaborates with astronomers in research; strong government involvement in radio astronomy

Computing at U of T



University of Toronto

Astronomers were among the first users of FERUT in 1952, and have been at the forefront of computing ever since

Dr. Beatrice Worsley

Earth and Planetary Science

J. Tuzo Wilson (1908-1993) CC, OBE, FRS, FRSC

- Wilson: first Professor of Geophysics in 1946
- Built a strong geophysics group which continues
- Now includes planetary science (and Planetary Science Institute at UTSC)
- Wilson went on to become Principal of U of T Mississauga, Director of Science Centre, Chancellor of York U

McLaughlin Planetarium (1968-1995)

- Proposed by U of T astronomers, and by RASC; located at ROM
- One of world's major planetariums during its lifetime; presented a variety of popular public and school programs
- Hosted RASC Toronto Branch
- Closing was unfortunate and unnecessary

York University

http://astronomy.blog.yorku.ca

- Initially part of the University of Toronto (1959-1965); Glendon campus opened in 1961, Keele campus in 1965
- Active astronomy group in the Physics Department; also space physics; also history of science
- Very active public astronomy program

University of Toronto Mississauga

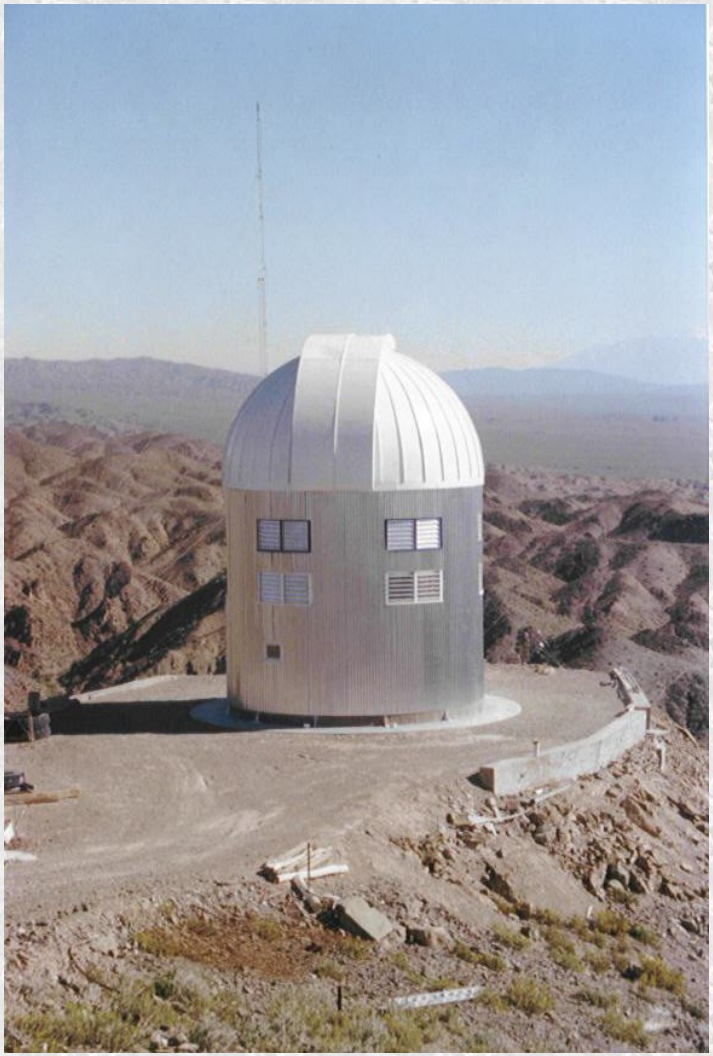
Magnetic studies of moon (and earth) rocks. Discovery of first black hole in space. Roberta Bondar did her PhD here.

Ontario Science Centre

http://www.ontariosciencecentre.ca

- Opened in 1969 as a late Ontario centennial project
- One of the world's foremost science centres; hands-on, minds-on
- Survived the “common sense revolution”
- Astronomy exhibits and programs; hosted the RASC Toronto Centre

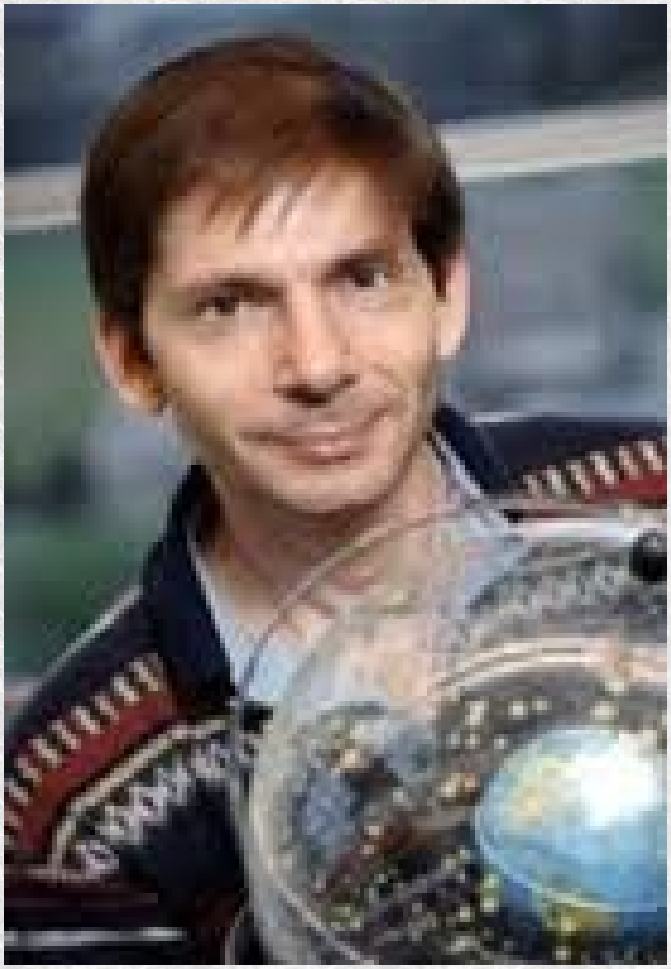
Astronomy Moves to Better Climes



- Sky conditions at the Dunlap Observatory deteriorated; by 2000, there was little research and no student training
- 1970+: astronomers were building small and large telescopes at superior sites in Chile (south) and Hawaii (north)
- University of Toronto Southern Observatory

Ian Shelton Discovers SN1987A

The brightest supernova visible in 400 years



Ian Shelton
University of Toronto

Canadian Institute for Theoretical Astrophysics

Richard Bond

- Founded in 1984 as a national centre for theoretical astrophysics, hosted by the U of T
- A very cost-effective way to do world-class science
- Former director Richard Bond is Canada's foremost astronomer; recipient of the Gruber Cosmology Prize etc.

Astronomy in Space: UTIAS

University of Toronto Institute of Aerospace Studies

- Engaged in a wide variety of research and development in aviation and space
- Built Canada's “Humble Space Telescope”, MOST (Microvariability and Oscillations of Stars)
- Built and launched six BRITE nanosatellites, successor to MOST

Astronomy in Near-Space

Balloon Astronomy

BLAST – Antarctic balloon flight

- Balloons: cheap way to put telescopes into near-space
- U of T is a key partner in a series of missions to observe cosmic microwaves (which are absorbed by the air)
- Targets: left-over radiation from the birth of the universe; star-formation in our galaxy

Dunlap Institute (2008 -)

- Funded with proceeds of the sale of the DDO
- Works closely with Astronomy Department, and CITA
- Emphasis on innovative instrumentation and observations; attracting bright young astronomers; strong public outreach
- Carries Dunlap name and bequest into 21st century

Teaching Astronomy Today at U of T

- Large (1,500) introductory courses for non-science students
- Taught by the best instructors, with “best practices” pedagogy and technology
- Courses for life science and physical science students
- Undergrad major, MSc and PhD programs

Public Outreach in Astronomy

- Astronomers – amateur and professional – love to share their knowledge and enthusiasm with the public
- For professionals: it's part of our accountability; the public pays for our salaries and research!

Astronomy and the Arts

Music, opera, theatre, dance, literature, art, photography

Astronomy Today

- Basic research on the nature, origin, and evolution of planets, stars, and the universe
- Space science and exploration – much of it motivated by politics and economics (not the same as astronomy)
- Education in universities and schools
- Many multidisciplinary and cultural connections: history, philosophy, literature, the arts.
- Unfortunately: for many/most people: widespread misconceptions and pseudoscientific beliefs

Amateur Astronomy Today

- Amateur astronomers: those who do astronomy (some with a high degree of skill) for a hobby
- Armchair astronomers
- Recreational skygazers
- Skilled instrument-developers and imagers
- Amateur researchers: “citizen scientists”
- Education and public outreach: a forte of the RASC and its Toronto and Mississauga Centres

THE FAR SIDE By GARY LARSON

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

UC by Starlight

Photography/PhotoShopping by Henry Leung III Astro & Phys

Resources

http://www.astro.utoronto.ca/~percy/heritagetalk.pdf

http://www.astro.utoronto.ca/~percy/heritagewalk.pdf

http://www.astro.utoronto.ca/~percy/heritagewalkmap.pdf

Looking Up: The Centennial History of the Royal Astronomical Society of Canada, by R. Peter Broughton, Dundurn Press (also on-line at the RASC website www.rasc.ca)

The Cold Light of Dawn: A History of Astronomy in Canada, by Richard Jarrell, University of Toronto Press