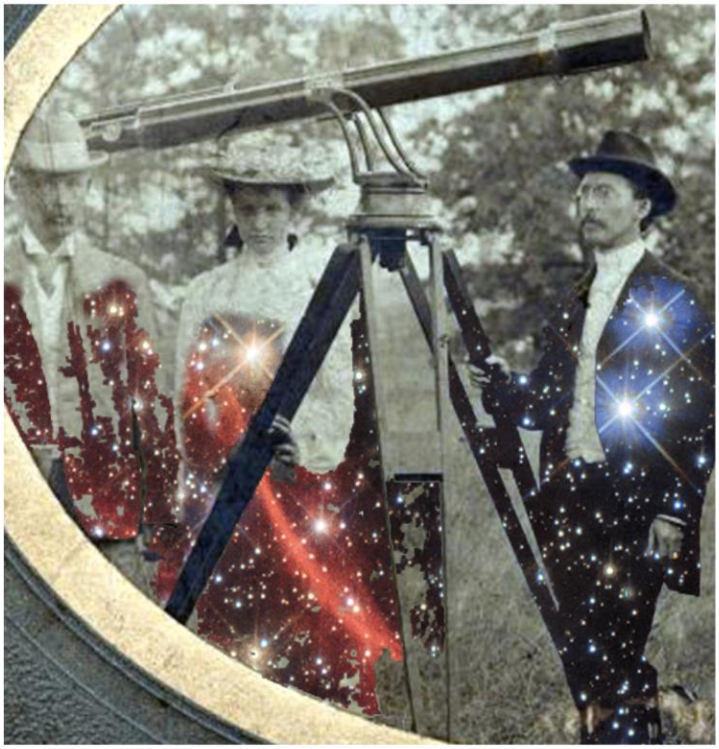
RASC History Committee Report NC185: *Robotic Telescope—Suggested Celestial Targets with Historical Canadian Resonance*



2018 September 16

Robotic Telescope—Suggested Celestial Targets with Historical Canadian Resonance

ABSTRACT: At the request of the Society's Robotic Telescope Team, the RASC History Committee has compiled a list of over thirty (30) suggested targets for imaging with the RC Optical System (Ritchey-Chrétien f/9 0.4-metre class, with auxiliary wide-field capabilities), chosen from mainly "deep sky objects which are significant in that they are linked to specific events or people who were noteworthy in the 150 years of Canadian history". In each numbered section the information is arranged by type of object, with specific targets suggested, the name or names of the astronomers (in **bold**) the RASC Robotic Telescope image is intended to honour, and references to select relevant supporting literature. The emphasis throughout is on Canadian astronomers (in a generous sense), and RASC connections.

NOTE: The nature of Canadian observational astronomy over most of that time changed slowly, but change it did, and the accepted celestial targets, instrumental capabilities, and recording methods are frequently different now than they were in 1868, 1918, or 1968, and those differences can startle those with modern expectations looking for analogues to present/contemporary practice. The following list attempts to balance those expectations, as well as the commemoration of professionals and amateurs from our past.

1. OBJECT: Detail of lunar terminator (any feature). ACKNOWLEDGES: 18th-19th century practical astronomy (astronomy of place & time), the practitioners of which used lunar observation (shooting lunars) to determine longitude. This object thereby commemorates the **astronomers of the Hudson's Bay Company and the Northwest Company,** as well as **the staff of the Dominion Observatory's time service** engaged in the 1957-1963 IGY study of ephemeris time through refining the Moon's position among the "fixed stars" with a Markowitz Moon Camera. REFERENCES: [Nevil Maskelyne,] *The Nautical Almanac and Astronomical Ephemeris, for the Year 1767*... (London: W. Richardson & S. Clark 1766); Malcolm M. Thomson, "The Beginning of the Long Dash" (typescript ca. 1978); John H. Hodgson, *The Heavens Above and the Earth Beneath: A History of the Dominion Observatories. Part 2: 1946-1970*, Geological Survey of Canada Open File 1945 (Ottawa: Energy, Mines and Resources Canada, 1994); Richard I. Ruggles, *A Country So Interesting: The Hudson's Bay Company and Two Centuries of Mapping, 1670-1870* (Montreal & Kingston–London–Buffalo: McGill-Queen's University Press, 1991).
2. OBJECT: Sun in integrated white light, or Hα. ACKNOWLEDGES: solar physicists **George Ellery Hale** (1868-1938), and **Arthur Covington** (1913-2001). Hale, an honorary RASC member, co-invented the spectroheliograph (1890s), discovered Zeeman splitting in sunspots (1908), and was the co-discoverer of the Hale-Nicholson Law (the polarity of sunspots in each solar hemisphere switches orientation from one sunspot cycle to the next, 1919). He supported the development of astrophysics in Canada, and professional and amateur astrophysicists of the RASC, such as J.S. Plaskett, and Allan F. Miller. Arthur Edwin Covington was Canada's first radio astronomer. He established the daily 10.7-cm solar flux patrol in 1947, which became one of the chief indexes of solar activity, and it has been maintained ever since (using some of the same apparatus to ensure continuity). He also discovered the Slowly-Varying or S-component of solar radio emission. REFERENCES: Adriaan van Maanen, "George Ellery Hale, 1868-1938", *JRASC* 32, 2 (1938 April), 192-194; A.E. Covington, "Micro-Wave Solar Noise Observations During the Partial Eclipse of November 23, 1946", *Nature* 159 (1947 March 22), 405-406; Helen Wright, *Explorer of the Universe: A Biography of George Ellery Hale* (New York: E.P. Dutton & Co., 1966); *The Legacy of George Ellery Hale: Evolution of Astronomy and Scientific Institutions, in Pictures and Documents*, ed. Helen Wright, Joan N. Warnow, and Charles Weiner (Cambridge MA: MIT

Press, 1972); Richard Jarrell, "The Formative Years of Canadian Radio Astronomy", *JRASC* 91, 1 (1997 February), 20-27. *Note: the image can best be taken with a dedicated solar instrument carried on the same mount as the 0.4-m RC.*

3. OBJECTS: Milky Way star fields (*e.g.*, "Rho Ophiuchi", Barnard 1927, pl. 13; "Region in Ophiucus and Scorpius", pl. 18; "Great Star Clouds in Sagitarius", pl. 26; "Region in Aquila", pl. 39; "Region of the North American Nebula", pl. 46). ACKNOWLEDGES: **Edward Emerson Barnard** (1857-1923), pioneer of wide-field astrophotography, prolific discoverer of comets, Amalthea (Jupiter V), first cataloguer of dark nebulae, and honorary RASC member. Barnard materially aided the Society in 1919 by delivering two well-attended lectures in Toronto to promote the Society's latest plan to raise funds for a public telescope. REFERENCES: J.A. Parkhurst, Edward Emerson Barnard 1857-1923, *JRASC* 17, 3 (1923 April), 97-103; Edward Emerson Barnard, *A Photographic Atlas of Selected Regions of the Milky Way*, ed. Edwin B. Frost & Mary R. Calvert, pts. I-II (Washington: Carnegie Institution of Washington, 1927). *Note: effective details of the fields can be taken with the 0.4-m RC, or if Barnard's wide fields are to be replicated, an auxiliary wide-field camera and lens could be used.*
4. OBJECTS: galaxies (*e.g.*, M51, M81 & 82, M101, NGC 6260, NGC 7331 [& NGC 7335, NGC 7336, NGC 7337, and NGC 7340]). ACKNOWLEDGES: **George Willis Ritchey** (1864-1945), master optician, co-inventor of the Ritchey-Chrétien system, and superb DSO photographer. Ritchey's most extended periodical publication of his ideas for large photographic reflecting telescopes appeared in *JRASC*. REFERENCES: G.W. Ritchey, "The Modern Photographic Telescope and the New Astronomical Photography-Part I. The Fixed Universal Telescope", *JRASC* 22, 5 (1928 May-June), 159-177; *ibid*., "The Modern Photographic Telescope and the New Astronomical Photography-Part II. The Ritchey-Chrétien Reflector", *JRASC* 22, 6 (1928 July-August), 207-230; *ibid*., "The Modern Photographic Telescope and the New Astronomical Photography-Part III. The Ritchey-Chrétien Aplanatic Reflector", *JRASC* 22, 8 (October), 303-324; *ibid*., "The Modern Photographic Telescope and the New Astronomical Photography-Part IV. Astronomical Photography with very High Powers", *JRASC* 22, 9 (November), 359-382; *ibid*., "The Modern Photographic Telescope and the New Astronomical Photography-Part V", JRASC 23, 1 (1929 January), 15-36; *ibid*., "The Modern Photographic Telescope and the New Astronomical Photography-Part VI", *JRASC* 23, 4 (1929 April), 167-190. *Note: the 0.4-m RC is tailor-made for these objects, and to commemorate G.W. Ritchey a RC system is fitting.*
5. OBJECTS: showcase northern globular cluster and planetary nebula (*e.g.*, M13, & M57). ACKNOWLEDGES: **John Stanley Plaskett** (1865-1941), the first Canadian astrophysicist with an international reputation. Plaskett had a long standing interest in astrophotography, and to show his skill, and the capabilities of the DAO 72-inch, he took photographs of M13 and M57, which were widely distributed throughout the world at the time (*e.g.*, through the medium of Chant's *Our Wonderful Universe*, and the sales of the Royal Astronomical Society slides). REFERENCES: Clarence August Chant, *Out Wonderful Universe: An Easy Introduction to the Study of the Heavens*, 1st ed. (London: George G. Harrap, 1928), pp. 166 (M57), 180 (M13); R. Peter Broughton, *Northern Star: J.S. Plaskett* (Toronto–Buffalo–London: University of Toronto Press, 2018), p. 198.
6. OBJECTS: Globular clusters with significant populations of variable stars (*e.g.*, M3 [NGC 5272], M5 [NGC 5904], M14 [NGC 6402], M15 [NGC 7078], M62 [NGC 6266]). ACKNOWLEDGES: **Helen Sawyer Hogg** (1905-1993), expert on variable stars in globular clusters, and astronomy popularizer. REFERENCES: Helen B. Sawyer, "A Catalogue of 1116 Variable Stars in Globular Star Clusters", *Publications of The David Dunlap Observatory of the University of Toronto*, I, 4 (Toronto: The University of Toronto Pres, 1939), pp, 125-177; Helen B. Sawyer, "A Second Catalogue of Variable Stars in Globular Clusters Comprising 1,421 Entries", *Publications of The David Dunlap Observatory of the University of Toronto*, II, 2 (Toronto: The University of Toronto Pres, 1955), 33-93; Helen Sawyer Hogg, "A Third Catalogue of Variable Stars in

Globular Clusters Comprising 2,119 Entries", *Publications of The David Dunlap Observatory of the University of Toronto*, 3, 6 (Toronto: The University of Toronto Pres, 1973), 1-75.

7. OBJECTS: meteor trail (or shower). ACKNOWLEDGES: **RASC meteoriticists Peter M. Millman** (1906-1990)**, Ian Halliday** (1928-2018)**, D.W.R. McKinley** (1912-1984)**, & Carlyle Beals** (1899-1979). Peter Millman was an expert on meteor spectra, and a pioneer in Canadian airborne astronomical missions, who with colleagues made Canadian meteoritics after the Second World War a force to be reckoned with. Ian Halliday was the lead in the development and operation of the Canadian Meteorite Observation and Recovery Project (MORP), and he lead the recovery of the Innisfree meteorite (1977), one of the very few meteorites recovered with a reliable orbit. The meteorite flux rates he published are considered standard. D.W.R. McKinley did pioneering work in meteor radar (his textbook from the early 1960s is still a recognized source). And Carlyle Beals, the penultimate Dominion Astronomer, besides his important work on the interstellar medium and Wolf-Rayet and P Cygni stars, initiated and oversaw the discovery program of impact cratering on the Canadian Shield. REFERENCES: R.A. Rosenfeld, ACOM & MIAC Calendar of Documents 1.3 (Toronto: RASC Archives, 2016) www.rasc.ca/sites/default/files/ACOM-MIAC_Calendar_of_Documents_3.pdf. *Note: the auxiliary wide-field camera will produce the best results.*
8. OBJECTS: reflection nebulae (*e.g.*, vdB 31, vdB 36 [Witch Head Nebula IC 2118], vdB 141 [Ghost Nebula], vdB 142, vdB 147). ACKNOWLEDGES: **Sidney van den Bergh** (1929-), one of Canada's (and the RASC's) most highly productive, and decorated astronomers. He has done fundamental work in an impressive diversity of astronomical fields. With a colleague he developed a widespread system of polychrome photometry, he has developed an important classification of galaxies, made estimates of the extragalactic distance scale, and of the age and size of the universe. He was one of the recipients of the Gruber Prize in Cosmology in 2014. REFERENCES: Sidney van den Bergh, "A Study of Reflection Nebulae", *AJ* 71, 10 (1966 December), 990-998; Sidney van den Bergh, *Galaxy Morphology and Classification* (Cambridge: Cambridge University Press, 1998).
9. OBJECTS: black hole(!) (*e.g.*, Cygnus X-1). ACKNOWLEDGES: **Tom Bolton** (1943-). In 1971, Tom Bolton working at the David Dunlap Observatory was able to confirm the discovery by Louise Webster and Paul Murdin of the RGO of a massive hidden companion to the star HDE 226868 (HDE 226868 had only just been identified as the energetic x-ray source Cygnus X-1). The first widely accepted black hole candidate, it remains among the best cases for identification as a black hole. REFERENCES: B. Louise Webster & Paul Murdin, "Cygnus X-1 a Spectroscopic Binary with a Heavy Companion?", *Nature* 235 (1972 January 7), 37-38; C.T. Bolton, "Identification of Cygnus X-1 with HDE 226868", *Nature* 235 (1972 February 4), 271-273. *Note: while a black hole cannot be directly imaged, that impossible feat is in fact not required for this project. Cygnus X-1 is in an attractive star field (also with interesting dark nebulae). It is sufficient to take an attractive picture, and merely indicate where Cygnus X-1 resides in the field. With knowledge of the historical background, the onlooker's imagination will make the view compelling.*
10. OBJECTS: compact galaxy groups (*e.g.*, HGC 10 [NGC 536, NGC 529, NGC 531, NGC 542], HGC 31 [NGC 1741A, PGC 16570, NGC 1741B, PGC 16571], HGC 44 [NGC 3185, NGC 3187, NGC 3190, NGC 3193], HGC 79 [NGC 6027, NGC 6027a, NGC 6027b, NGC 6027c, NGC 6027d, NGC 6027e - tidal tail of NGC 6027], HCG 90 [NGC 7176, NGC 7173 and NGC 7174], HGC 92 [NGC 7317, NGC 7318A, NGC 7318B, NGC 7319, NGC 7320C]). ACKNOWLEDGES: **Paul Hickson** (1950-). Paul Hickson is an astrophysicist at UBC, Director of the innovative Large Zenith Telescope Project (largest optical telescope on the Canadian landmass) and other liquid mirror experiments, and has been heavily involved with Canadian efforts on the Thirty Metre Telescope. In 1982 he published a catalogue of compact groups of galaxies, the groups containing typically four or five tightly packed members, many of which are merging, or otherwise interacting. REFERENCES: Paul Hickson, "Systematic Properties of Compact Groups of

Galaxies", *ApJ* 255 (1982), 382-391; Paul Hickson, "Compact Groups of Galaxies", *Annual Review of Astronomy and Astrophysics* 35 (1997), 357-388.

11. OBJECTS: supercluster (*e.g.*, Virgo supercluster, or any member, or members thereof). ACKNOWLEDGES: **Laura Ferrarese**. Laura Ferrarese has been a leader in the study of supermassive black holes and their host galaxies, the extragalactic distance scale and the expansion rate of the universe. She is the Principal Investigator of the Next Generation Virgo Cluster Survey (NGVS), is just finishing her term as Interim Director of the Gemini Observatory, and is commencing as a Vice President of the International Astronomical Union. The Next Generation Virgo Cluster Survey (NGVS) is delivering an unprecedented view of baryonic substructures spanning a factor 10^7 in mass, from supra-L* giants to small spheroidal galaxies, tidal debris and globular star clusters, and serve as a much needed local reference point for observational tests of cosmological models. REFERENCES: Laura Ferrarese, Patrick Côté, et al., "The Next Generation Virgo Cluster Survey (NGVS). XIII. The Luminosity and Mass Function of Galaxies in the Core of the Virgo Cluster and the Contribution from Disrupted Satellites", *ApJ* 824: 10 (2016 June 10).
12. OBJECTS: memorable amateur asterism (*e.g.*, Kemble's Cascade). ACKNOWLEDGES: **Fr. Lucian J. Kemble, OFM** (1922-1999). Fr. Kemble was an experienced observer of the deep sky, who left abundant records of his explorations of the heavens. A long-time RASC member, he was a good observing companion, and mentor to many serious visual observers. REFERENCES: Walter Scott Houston, *Deep-Sky Wonders*, ed. Stephen James O'Meara, Stargazing Series (Cambridge MA: Sky Publishing Corporation), pp. 30-33. *Note: the object would benefit from the auxiliary wide-field camera, but it could be taken by stitching images taken with the 0.4-m RC.*
13. OBJECTS: asteroids with a Canadian connection (*e.g.*, 2154 Underhill, 3269 Vibert-Douglas, 3315 Chant, 3316 Herzberg, 4113 Rascana). ACKNOWLEDGES: the naming of asteroids through the Working Group for Small Body Nomenclature (CSBN) of the IAU allows the community to honour members of the astronomical community, and institutions. Prominent Canadian astronomers so honoured include **Clarence Augustus Chant** (1865-1956), the founder of modern university education in astronomy in Canada, **Allie Vibert Douglas** (1894-1988), the first women in Canada to become a professional astrophysicist, **Gerhard Herzberg** (1904-1999), who worked as a spectroscopist at Yerkes Observatory, won the Nobel Prize for Chemistry in 1971, and whom the NRC Herzberg Astronomy and Astrophysics Research Centre is named, **Anne Barbara Underhill** (1920-2003), who worked on early-type stars. The RASC itself has been honoured with an asteroid. REFERENCES: www.rasc.ca/asteroids-canadian-connection; https://ssd.jpl.nasa.gov/sbdb.cgi.

—R.A.Rosenfeld 1.2

Respectfully submitted,

R.A. Rosenfeld, Chair

Committee Members:

- ***Randy Attwood, FRASC (ED)***
- *Chris Beckett (Unattached)*
- *Dr. Roy Bishop, FRASC (Halifax)*
- *Eric Briggs (Toronto)*

• *Peter Broughton, FRASC (Toronto)*

• *Dr. Karen Finstad (Ottawa Centre)*

• *Dr. Chris Gainor, RASC National President (Victoria)*

• **Renata Koziol (Accounting Manager)*

• *Heather Laird (Calgary)*

• **Barry Matthews (Ottawa Centre, observer)*

• *Clark Muir (Kitchener-Waterloo), Vice Chair*

• *Andrew Oakes (Unattached)*

• *Randall Rosenfeld (Unattached), Chair*

• *Dr. Mark Tovey (London)*

**=non-voting members*