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Chapter 14

Canadian Contributions to SETI—Past and Present*

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Abstract

Canadians have historically contributed to all aspects of the scientific search for manifestations of extraterrestrial intelligent life (SETI) in the universe. During the 1970s Canada's largest radio telescope at Algonquin Radio Observatory (ARO) was used to search for extraterrestrial beacon transmissions at the water molecule frequency. In 1982 the Algonquin facility was once again approved for use in a SETI search for strongly polarized radio signals emitted from artificial transmitters. Aside from direct SETI searches, Canadians have contributed to a greater understanding of the origin of life, biology, and evolution of intelligence. A Canadian paleontologist created a furor in 1982 over a life-sized, clay model depicting a dinosaur today, after an additional 65 million years of evolution. The importance of the social sciences for SETI was championed by Allen Tough and other Canadians presenting ideas and projects during the 1990s and 2000s that generated new ways of thinking not only about SETI, but the societal implications of first contact and the effect of our own culture and history on SETI. Canadians participate in SETI@Home, are members of the SETI League and operate their own amateur search programs on backyard telescopes,

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have led the effort to send directed transmissions to space, and serve on the International Academy of Astronautics SETI Permanent Committee, and other groups and research programs focused on SETI or astrobiology. The Canadian Astrobiology Training Program for undergraduate, graduate, and postdoctoral researchers interested in the scientific search for life in the universe is underway at several Canadian universities and Canadian scientists are working on innovative instrumentation for near infrared optical SETI detectors to look for pulsed laser signals emanating from extraterrestrial civilizations.

I. Introduction

Amid widespread social and technological change at the dawn of the 1960s, Canada became the third country to join the Space Age, with the launch of the *Alouette 1* satellite in 1962. Soon after, the federal government redirected space technology research to focus on specific applications, including communications and remote sensing. At the time, despite the proliferation of television sets, 20 percent of Canadians had no access to telecommunication services. With the launch of *Anik 1* in 1972, Canada became the first country to use a geosynchronous satellite for domestic communications, and the entire country had access to live television. This was not without controversy, with some debate over whether inhabitants of remote arctic Canada would appreciate live news and television shows such as *Bonanza* beamed into their living rooms. However, the chance to watch Hockey Night in Canada live, instead of on prerecorded tape, was hugely popular, and the country was finally connected coast to coast.

In 1974, another project aimed at communication was taking place in Canada, this time at the Algonquin Radio Observatory (ARO) in Ontario. Instead of using communication equipment and technology to bring live television signals to northern Canada, this time it was used to scan the universe to detect signs of technologically-advanced extraterrestrial civilizations.

II. Algonquin Radio Telescope

Nestled in beautiful Algonquin Park, Ontario, is a majestic 46-meter radio telescope originally built by the National Research Council of Canada (NRC) for radio astronomers who needed a quiet site with minimal radio interference. The telescope started operations in 1966 and its first project was to demonstrate Very Long Baseline Interferometry.

Starting in 1974, the ARO was the site for the first Canada-based SETI search. Then, as now, devoting government funded time on the facility to look for transmissions from other civilizations was controversial and took several years for approval.* Inspired by the Cocconi and Morrison[1] paper on using the 21-cm hydrogen line as a logical place to look for radio signals of extraterrestrial origin, radio astronomers Alan Bridle and Paul Feldman, came up with the idea of searching the frequency emitted by water molecules and designed a search for narrow water-line emissions from nearby solar-type stars. Although the 1.35-cm emission line from water molecules would not normally be detectable, the notion was that it may be used as a "beacon frequency" by water-based life forms. As a bonus, the frequency was in an area of low background noise.

As is common with many SETI searches, details of the search were never published due to null results; however the authors presented at several conferences at the time and the search is included in the search archival list in Tarter[2] and on the SETI Institute website.† The Bridle and Feldman search is described as having taken 140 hours from 1972 to 1976, although the first few years were devoted to planning the search and obtaining authorization. A total of 70 solar-type stars within 45 light years were observed.

In 1982, the 46-meter telescope at the ARO was used for another SETI search. While working on a study of the galactic magnetic field structure, Jacques Vallée and Martine Simard-Normandin conducted a search for highly polarized signals that are specific to artificial transmitters, such as television. Since no natural source emits radiation that is more than 70 percent linearly polarized, discovery of highly polarized signals may indicate some type of extraterrestrial communication system. The observers made seven observing runs of roughly three days each to scan for strongly polarized radio signals at the wavelength of 2.82 cm. Full details of the search are provided in Vallée and Simard-Normandin.[3]

The NRC made the decision in 1986 to shut down the ARO after a series of government budget cuts. The facility needed to be upgraded at a cost of $10 million and it was decided instead to participate in the new James-Clerk-Maxwell Observatory to be built on Mauna Kea, Hawaii, as part of an international consortium.

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* Alan Bridle kindly elaborated on the SETI search project in an email (2014) to the author, and much of this section is summarized from this communication.

† The Feldman and Bridle SETI search is named "Qui Appelle?" which can be translated to "Who is Calling?" Oddly, when asked about this, Alan Bridle notes that name of the search did not come from the observers, but was rather assigned to the project by some other party.

During this period, and with a skeleton staff operating the ARO, a new option surfaced. In the late 1980s, the National Aeronautics and Space Administration (NASA) was planning a large SETI program and the ARO was on the short list of sites under consideration to be used as a dedicated SETI facility. Ultimately, the ARO was not chosen, greatly disappointing Canadian officials who were very keen to keep the ARO active. The NASA-sponsored SETI program was cancelled in 1993.

While efforts to keep the ARO operational continued, an amateur SETI search called Project Target was being conducted after hours by one of the technicians on site, using the smaller 16-meter radio telescope. The technician, Robert Stephens, had also conducted a privately funded SETI search of the 21-cm hydrogen line in the mid-1980s using two decommissioned Distant Early Warning (DEW) 18-meter antennas on an island near Hay River, Northwest Territories, in northern Canada (Tarter[2]).

Between 1999 and 2006 the ARO was operated by the Geodetic Survey Division of Natural Resources Canada in partnership with the Space Geodynamics Laboratory. After a catastrophic malfunction of the foundation for the 46-meter telescope, plans were made for decommissioning. Prior to its demolition, the ARO astonishingly experienced another resurrection in 2008 through the lease of the facility by private-sector Thoth Technology, Inc., for a period of twenty years. The company took on the repair work for the telescope, and now supplies geodetic and deep space network services to industry and academic clients for space-tracking and communications with near-Earth and interplanetary spacecraft. The 46-meter antenna remains the largest in Canada and one of the largest fully steerable dishes in the world. The onsite atomic clock loses less than one second in 30 million years, and keeps Global Positioning System (GPS) measurements accurate. The new operator of the ARO facilities has an international cliental, so the telescope may well be used in the future for tracking Chinese missions to Mars and other endeavors.

III. Evolution and Intelligence

The search for intelligent extraterrestrial life in the universe encompasses an understanding of biological and evolutionary science and the concept of intelligence. Millions of species have existed on Earth, yet only *Homo sapiens* evolved to develop technological intelligence capable of detecting other life in the universe. An interesting Canadian contribution to this area of SETI features a clay model of what a dinosaur might look like today, after an additional 65 million years of evolution.

Dale Russell, a paleontologist working at the National Museum of Natural Sciences in Ottawa, was studying Stenonychosaurus, a small, nimble ostrich-like dinosaur which lived about 75 million years ago. Most dinosaurs, including the well-known Tyrannosaurus had remarkably small brains, given their gigantic body mass. Examination of the fossil record showed evidence that dinosaur brain size increased with time, and that Russell's Troodon (as it is now called) had a brain-to-body ratio six times larger than other dinosaurs. In his bestselling book, *The Dragons of Eden—Speculations on the Evolution of Human Intelligence*, Carl Sagan[4] took note of Russell's work and postulated on what would have happened if the smartest of the dinosaurs had evolved an additional 65 million years, instead of being annihilated during at the end of the Cretaceous Period. Would they have evolved to be as intelligent as *Homo sapiens*?

Dale Russell teamed up with Ron Séguin, an expert on taxidermy and modeling. The most complete skeleton of Troodon, collected in Dinosaur Provincial Park in Alberta, served as a base model for their work. The 60-kilogram Troodon had a large brain relative to other dinosaurs, stereoscopic vision, opposable fingers, and bipedal stature. The authors wanted to promote a high-level academic discussion on the effects of brain size and body size on vertebrate morphology. The resulting paper (Russell and Séguin[5]) presented startling photos of a life-size, large-eyed dinosaur that looked remarkably human, thereby creating a sensation in the press. Popular culture variations of the clay model "dinosauroid" continue to pop up to this day and the dinosauroid evolutionary path is still a topic of discussion in articles and blogs (Naish[6]).

The furor over the humanoid appearance of the evolved dinosaur keyed into deep psychological and sociological aspects of the search for extraterrestrial life in the universe. The key question in our minds is...will they look like us? The debate over the dinosauroid model was not so much the concept, but whether the familiar humanoid form is an inevitable outcome for an evolved technological species.

IV. Rise of the Social Sciences

Consideration of cultural and societal aspects of the detection of extraterrestrial life has always been an important topic, even in the early days of SETI. These issues were discussed in the first SETI (or "CETI" as it was called then) meetings in the 1960s and 1970s. By the 1980s, the legal, political, and societal implications of the detection of extraterrestrial life became higher profile.

A soft-spoken, pleasant, Canadian professor, known for his research into adult learning, became a significant influence in the SETI field, not only in terms

of his research and contributions, but also in his generosity in supporting others in their SETI efforts.

In the 1980s, Professor Allan Tough at the University of Toronto started thinking about the future and the meaning of the search for signs of extraterrestrial intelligent life in the universe. Until his untimely passing in 2012, Allen Tough focused on three areas of interest: the very long-term future of human civilization, the scientific search for extraterrestrial intelligence, and humanity's search for meaning and purpose on the individual and societal levels.

In 1999, on the beautiful island of Hawaii, Allen organized and coordinated a conference hosted by The Foundation for the Future, and held in conjunction with the larger "Bioastronomy '99: A New Era in the Search for Life in the Universe" conference. Allen Tough put together a unique blend of scientific and social expertise for the workshop. The 16 participants included an anthropologist, psychologist, artist, Buddhist priest, and social scientists along with radio astronomers and engineers. Results of the workshop, where participants were encouraged to think ahead to the year 3000, are presented in *When SETI Succeeds: The Impact of High-Information Contact.*[7]

The World Wide Web emerged during the 1990s. Intrigued with the idea of small, smart interstellar probes lurking in our Solar System (Tough[8]) Allen decided that the internet is a perfect medium through which a lurking probe could learn about humanity. He established the website "Invitation to ETI," an innovative and out-of-the box approach to SETI.

While Allen Tough always looked towards the future, another Toronto-based social scientist examines the past and uses first contact scenarios through human history as an analog for SETI. Kathryn Denning, an anthropologist and archaeologist at York University in Toronto has put forward ideas on what it means to seek an understanding of other civilizations distant from modern humans in time, with very little physical evidence from which to interpret. She examines technology from a historical perspective and proposes that the development of the radio technology used in modern SETI research was driven by a tenuous series of interweaving events relating to our culture, social structures, and even our economic and political status (Denning[9]). Her contributions to SETI have led to new thinking about looking for life in the universe and what we can learn from our own history.

V. Astrobiology Programs in Canada

Canada was one of the first countries to have an undergraduate course taught on life in the universe. During the 1970s there was great interest in the

Viking lander missions to Mars. Alan Bridle, one of the observers of the 1974 SETI search at the ARO, formed a collaboration with members of the biology and geology departments at Queen's University to conduct a "Planets and Life" undergraduate course, one of the first to teach exobiology concepts from a serious scientific perspective.

Today in Canada, students can enter astrobiology programs at McGill University, McMaster University, University of Western Ontario, University of Toronto, and the University of Winnipeg. The programs and research combine elements of geology, chemistry, physics, astronomy, microbiology, and robotics. The federal government is providing funding through the Astrobiology Training Program and collaboration with groups in the United States, such as NASA and the the SETI Institute. The end goal is to increase Canada's involvement with U.S. and European space exploration missions with a possible future for an entirely Canadian astrobiology mission to Mars. New students can take inspiration from leading Canadian scientists now working on the discovery and analysis of exoplanets and their atmospheres.

VI. SETI in Canada—Present Day

University of Toronto scientist Shelley Wright is leading a collaborative effort to build a Near Infrared Optical SETI detector designed to detect pulsed laser signals emanating from an extraterrestrial civilization. This project is unusual in that not only will the instrument be relatively inexpensive and easy to duplicate, (Wright et al.[10]) but it can also be used to search for transient flashes from natural objects, such as pulsars and black holes. Plans are to install the instrument at the Lick Observatory on a one-meter telescope, with the added bonus that observations can be made remotely which increases the number of observers and offers opportunities for educational purposes.

The concept of the search for some sign of extraterrestrial intelligent life in the universe is tremendously popular with the general public. The movie *Contact* is well-known, and there is a general awareness of the exoplanet discoveries. Many Canadians belong to The Planetary Society, the largest space advocacy group in the world, which is a long time sponsor of SETI searches. Simon Fraser University, the University of Toronto and others have hosted recent public symposia and events centered on the search for life in the universe.

On May 17, 1999, the SETI@Home project, based at the Space Sciences Laboratory at the University of California, Berkeley, was launched. The collected computing power of volunteer personal computers is used to analyze data from the Arecibo Radio Telescope in Puerto Rico. This groundbreaking and innovative

program lists 1.5 million users and 63,000 teams on its website, with Canada ranking fourth in total users at 48,069 after the United States, Germany, and the United Kingdom.

The SETI League, an alliance of amateur and professional radio astronomers, ham radio operators, digital signal processing enthusiasts, and other supporters, has 1,548 members, of which 43 members are from Canada. The SETI League coordinates Project Argus, an all-sky survey for microwave signals using inexpensive amateur radio telescopes and receiving systems built by individual members.

Canadian scientists and students studying astrobiology often collaborate with scientists working out of the SETI Institute in Mountain View, California, a private, nonprofit organization dedicated to scientific research, education, and public outreach.

Members of the SETI Permanent Committee of the International Academy of Astronautics include four Canadians; Kathryn Denning, Stephane Dumas, Yvan Dutil, and Lori Walton. This committee (http://avsport.org/IAA/) has existed since the early 1970s and meets annually during the International Astronautical Congress to conduct two SETI sessions and conduct SETI business. The SETI Permanent Committee is charged with examining all aspects of possible future contact with extraterrestrial civilizations, including science and technology, philosophy, historical analogs, anthropology, legal, political, and institutional issues, sociology, psychology and theology, and interactions with the media and education system. One of the functions of the committee is to establish protocols to be followed by SETI scientists in the detection, analysis, verification, announcement, and response to signals from extraterrestrial civilizations.

All issues concerning possible transmissions from Earth deliberately intended for extraterrestrial civilizations are considered by the SETI Permanent Committee. Canadians Yvan Dutil and Stephane Dumas and several others are involved in the design and transmission of deliberate radio messages sent from Earth and targeted at various stars. Although not a search for life in the universe, various technical and social aspects of message construction overlap with SETI searches.

VII. The Future of SETI in Canada

The Canadian Astrobiology Training Program is destined to educate a new generation of cross-disciplinary researchers used to working in collaboration with others on a wide variety of topics pertaining to life in the universe; a very positive development for Canadian science. Yet funding support for Canadian astro-

nomical science and related endeavors is declining, and Canadian participation on key projects that may provide insight to life in the universe is in question.

A comprehensive vision for Canadian astronomy to the year 2020 (CSA[11]) describes the impact of the discovery of intelligent life in the universe as having the potential to revolutionize society and states that the detection of life is a far-reaching goal of modern science. A summary report on Canadian radio astronomy (Claude[12]) includes the search for life in the universe as a priority. These planning and reporting documents, together with the Canadian Astrobiology Training Program, represent support by Canadian science policy decision-makers for the scientific search for life in the universe. Yet, one small step further is not taken; made apparent by the lack of strategies and provisions for direct SETI searches.

The wide policy gap separating funding support for astrobiology but not SETI searches may narrow when success is declared after bacteria or simple life forms are found in the Solar System, or when biosignatures are detected in exoplanet atmospheres or elsewhere. But, as Canadian social scientists have stated, humanity is most interested in knowing if there are others in the universe like us; others we could learn from and communicate with. An interesting scenario would be if Canada's largest radio telescope facility at Algonquin Park could be used, once again, to search for manifestations of technologically advanced extraterrestrial life in the universe.

VIII. Conclusion

To fully comprehend and conduct a scientific search for extraterrestrial intelligent life in the universe, one must understand not only the science and technology involved, but also the cultural, philosophical, and societal impact of discovering we are not alone. Canadians continue to influence and contribute to discoveries in the search for an examination of life signatures in our own Solar System and on exoplanets. But Canadian social scientists have also contributed to a deeper understanding of what it means for humanity to seek extraterrestrial intelligent life and where we might fit within a larger universe.

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