Project Centaur: unveiling the secret of the ephemeral Northern Lights

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"How would you like to go to Cape Perry in the high Arctic this November to observe the Northern Lights?"

When asked this question, visions of blizzards, long frigid nights spent outside, spectacular aurora and days without any sun immediately came to mind. I had of course heard of the location before. Cape Perry is on the coast of the Arctic ocean about 500 miles east of the Yukon Alaska border. Over two years of effort resulted in the design and building of an optical instrument for my Ph.D. thesis and this would be my first opportunity to test it. Naturally, I gave up the idea of staying in sultry Toronto or even better going south and said yes.

Part of PhD thesis

The campaign I was to be involved in was an international project involving scientists from Canada, the U.S.A., Denmark, Sweden and England. Project CENTAUR (*Ceft, Energetics Transport And Ultraviolet Radiation*) as the expedition was named, involved the firing of five rockets carrying scientific instru-ments to measure conditions in the region where the Northern Lights or *aurora* are formed. At the same time scientific instruments on the ground would be used to analyse the light from the Aurora.

Fortunately I was not the only person from York involved in the trip. My Supervisor Dr. G.G. Shepherd and research scientists Dr. William Gault and Dr. Rudy Weins also travelled to Cape Perry to operate a ground based instrument called the Cleft Detector. In addition another member of the York community, Roy Koehler, had specially designed probes on two of the rockets.

The optical instruments contributed by York were among the most sophisticated in the campaign. Both my instrument, a *Wide Angle Michelson Interferometer* or WAMI and the Cleft Detector were conceived, designed and built for the most part on campus. The WAMI was designed specifically to measure small shifts in the colour or wavelength of light emitted by molecules in the upper atmosphere.

The Cleft Detector was designed specifically to view Aurora during twilight. This is in general a difficult task because the light from the sun is far brighter than any light produced by the Aurora.

During the winter at Cape Perry, the sun remains below the horizon; it starts getting light at 11 a.m. and gets dark after 4 p.m.

There are several reasons why Cape Parry was chosen as the site for this campaign. First and foremost it was known that the type of Aurora being observed, the Dayside Cleft Aurora, would be observed from Cape Parry. Secondly some rocket launch facilities were already available there, and there were adequate facilities to house the sixty or so people involved in the campaign.

The dayside Cleft Aurora or the Cleft as it is often called is a phenomenon which was first identified in 1971 using data from the Canadian ISIS satellite. Dr. Shepherd's group at York has been highly involved in subsequent research on the phenomenon. In 1973, Dr. R. Peterson then a graduate student at York was the first person to observe the Cleft from Cape Parry and Dr. Shepherd's involvement in campaigns to Cape Parry in 1974 and 1977, as well as his analysis of data from the ISIS satellite have contributed a great deal to knowledge of this phenomenon.

Recent discovery

The reason for the recent discovery of the Cleft is due to the fact that it is only visible during the day, and therefor in general difficult to see by eye. Unlike the more familiar night Aurora, the Cleft Aurora is thought to be caused by particles travelling directly from the sun into the upper atmosphere and then causing light to be emitted through collisions with molecules there. In general this does not happen because the earth's magnetic field deflects the particles away from the atmosphere. The night Aurora is thought to be caused by changes in the earth's magnetic field.

An analogy to this would be what would happen to someone walking outside in a downpour without a hat on. Just after he leaves the building he would notice that it was raining from the force of the rain on his hair. The only place his scalp would get wet, however, would be at the crown of his head. The analogy holds in the sense that the rain could be considered particles from the sun, his head the earth, his hair the earth's magnetic field and the crown of his head the cleft region. The Cleft is the only region in which the particles from the sun enter the atmosphere directly.

Cape Parry or Pin Main as it is called in military jargon is one of the many DEW Line stations situated across the Canadian north. It is one of the early warning stations set up in the early sixties to provide "protection" against nuclear war. In normal times it supports about twenty-five people including military and radar personnel, and support staff. The arrival of the people involved in Project CENTAUR tripled this number.

My first impressions of Cape Parry were somewhat confused. I had expected to be met by the cold, vast, silent Arctic and instead found myself experiencing the somewhat surreal surroundings of a fairly sophisticated northern airstrip. The whole area was brightly lit. Several pieces of heavy machinery were dashing around unloading the plane and in front of me was a large hangar and several other buildings. After a short wait, we were picked up by bus and carried to our living quarters about a mile away. It was all very convenient but where was the real Arctic?

At around 2:00 p.m. on the first day our equipment arrived and we started working. In all around 20,000 lbs. of equipment were brought in and set up. The instruments were put outside in the snow and we stayed fairly warm in a garage nearby, with the recording apparatus. The final result was a small forest of ungainly and awkward black shapes connected by long cables to the garage. Whenever the instruments were in operation an assortment of whirrings, clicks and rasping noises could be heard. Anyone watching would be amazed that what he was seeing was science in progress.

The Northern Lights—silent ghosts moving to their own law.

It was the first time that both the Cleft Detector and WAMI had been out in the field so we had more than our share of problems in setting up. After a week or two of sixteen hour days the instruments were working and we started observing. In general the Cleft appeared in the early afternoon and since it was dark most of the day it could be observed at this time. The instruments were usually set up at 7:00 in the morning and ran until 10:00 at night.

This was the first time that I had a chance to observe Aurora for such an extended period of time and luckily there were quite a number of spectacular displays. A good part of several evenings were spent outside watching them.

Aurora like silent ghosts

It was amazing that something which appeared to be such a large scale phenomena could move so rapidly and so quietly. At one time the Aurora might be close to the horizon, fifteen minutes later overhead and half an hour later have disappeared. The forms varied from long rippling curtains of light to rays diverging from a point almost directly above to diffuse patches which drifted across the sky. The colours were usually a greenish-white, although at times there were reddish tints. I felt, a spectator watching a larger than life drama whose significance could be appreciated but not understood. The Aurora seemed like silent ghosts moving to their own law.

It was strange to think that we should be using something as directed and powerful as rockets to investigate such a fragile phenomena.

In total, five rockets were fired during the campaign. Four of these were of the very successful Black Brant series, manufactured by Bristol Aerospace in Winnipeg and originally developed at Defence Research Establishment Valcartier (DREV) in Quebec. The other was a Terrier Malemute provided by NASA.

The Black Brant X's are a new development. They are three stage rockets capable of carrying a 500 lb. payload 300 miles high. The two firings at Cape Parry were the first two operational firings of the rocket, and both were successful.

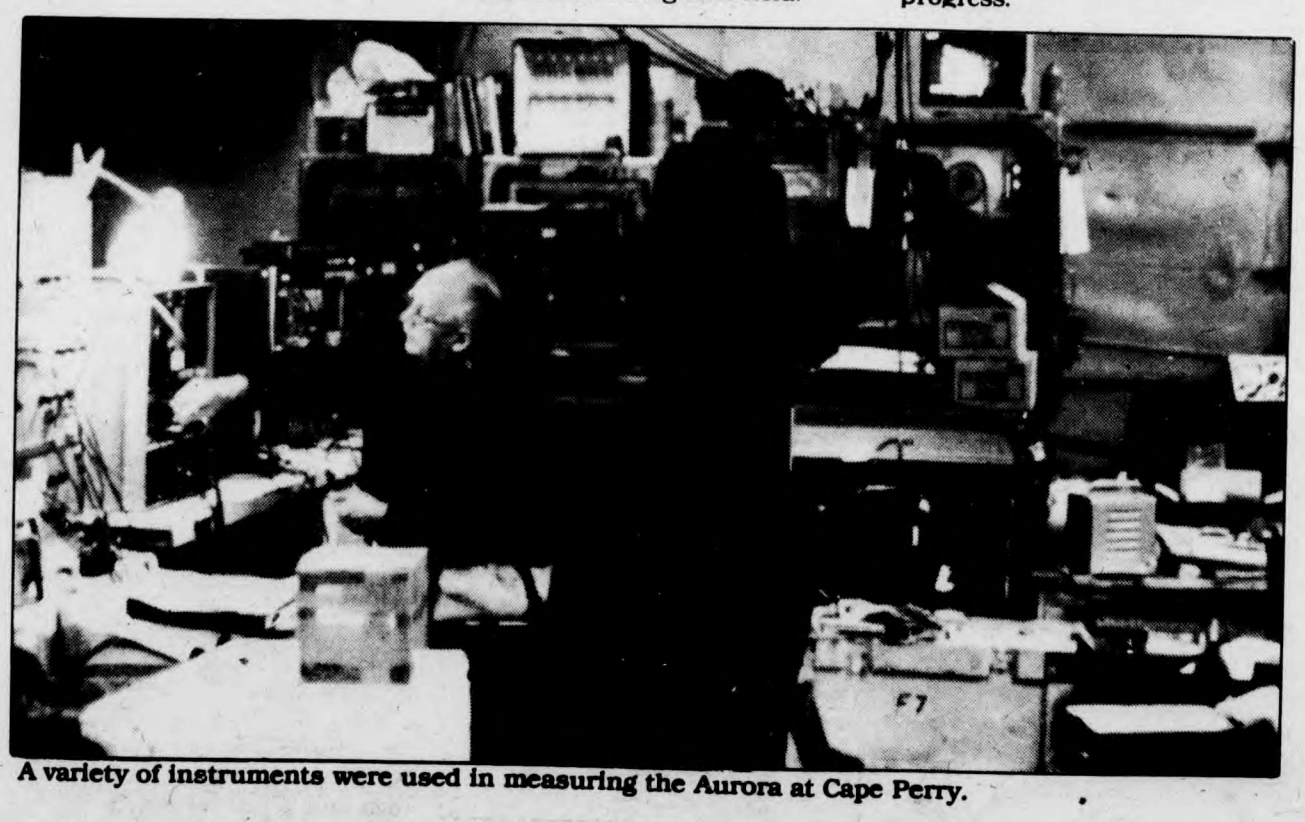
Rockets take off

We saw all the rockets take off. Before the flights we would be inside making sure the instruments were working and once the count-down reached one minute, would rush outside to where we could see the launch site, about a mile away. The count-down was actually broadcast throughout the base so we were joined by almost all the regular staff. There was usually a small crowd watching when the burst of flame followed by a muffled roar announced the firing of the rocket.

The last launch was on December 13, but observations continued until Dec. 18. Just as we were ready to bring the instruments inside a major blizzard struck. The winds were over 60 m.p.h., the temperature at -15°c and the visibility around 20 ft. The cables were buried under three feet of snow, moustaches and beards froze and in general everyone felt cold, wet and miserable. As the storm progressed into the third day there were fears that we would be stranded over Christmas.

In the end everything worked out. We finished packing and the storm broke the same day. The following evening the plane arrived to take us home.

I am often asked what the practical results of the trip there is no answer to these questions. It is like asking someone who is meeting for the first time whether they are going to get married. Instead the research which took place is most similar to a meditation on the Aurora. First we must understand and feel familiar with what is going on. Later we can decide what if anything we are going to do about it.



A variety of instruments were used in measuring the Aurora at Cape Perry.