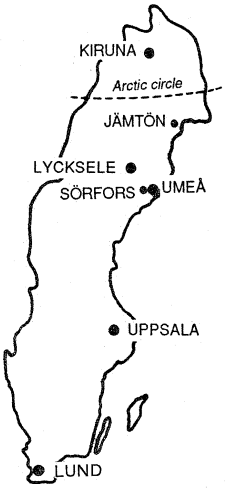
# The Swedish Institute of Space Physics, IRF

IRF conducts research and postgraduate education in atmospheric physics, space physics and space technology. Measurements are made in the atmosphere, ionosphere, magnetosphere and around other planets with the help of stratospheric balloons, ground-based equipment (including radar) and satellites. The first Kiruna-built satellite experiment was launched in 1968.

IRF was founded in 1957 as the Kiruna Geophysical Observatory, an institution within the Royal Swedish Academy of Sciences. Measuring equipment, however, had been in place in Kiruna since the end of the 1940s. IRF has been a state-owned research institute since 1973.

## IRF's offices:




IRF has offices in:
- Kiruna (at the Space Campus)
- Umeå (at Umeå University)
- Uppsala (at the Ångström Laboratory)
- Lund (at IDEON Science and Technology Park)

Research activities in Uppsala started in 1952 as a research station within the Swedish Defense Research Establishment. The Uppsala office became part of IRF in 1976.

Observations at the Ionospheric Observatory in Lycksele began in 1957, and the observatory became part of IRF in 1970.

IRF also has a station for measuring infrasound at Jämtön in Norrbotten.

## IRF instruments to Mars and Venus

A particle instrument, ASPERA, was developed at IRF for the two spacecraft on the Soviet *Phobos* mission, launched in July 1988. ASPERA measured electrons and positive ions in the energy range 0.001–25 keV. Particles within this range of energy participate in many interesting processes. On Earth they give rise to the aurora.

The Martian magnetic field is weak, so special plasma conditions exist there which are interesting for us to compare with those of the Earth. ASPERA made unique measurements in the atmosphere of Mars during the early part of 1989.

ASPERA 3 was launched in 2003 on ESA's *Mars Express* mission and is now orbiting Mars to study how the solar wind affects the Martian atmosphere. ASPERA 4 was developed for similar studies of the atmosphere of Venus on ESA's *Venus Express*, which orbited the planet 2006-2014.

As well as studying the Earth-like planets Mars and Venus, IRF has also made measurements at the gas giant Saturn.

*IRF has its head office at the Space Campus in Kiruna.*

## Satellite experiments

IRF participates in several international projects, where satellites as well as ground-based equipment are used.

At present, data from satellite experiments are being analysed to help us better comprehend the plasma-physical processes in the solar wind and around comets and planets. The successful Swedish satellites *Viking*, *Freja*, *Astrid 1* and *Astrid 2* have greatly increased our knowledge of auroral processes in the Earth's magnetosphere. IRF has built its own 6kg nanosatellite *Munin* (2000) and at present has satellite instruments in orbit round the Earth and Mars. IRF instruments have also recently studied Saturn and Comet 67P.

**Some recent and on-going projects are:**
- *Cassini* (1997-2017) was a NASA project to study Saturnus and its moon Titan.
- *Cluster* (2000) is an ESA project for research in the Earth's magnetosphere.
- *Mars Express* (2003) is an ESA mission to study Mars.
- *BepiColombo* (launch 2018) is an ESA/JAXA mission to Mercury—with 3 instruments contributions from IRF.
- *JUICE* (launch 2022) is an ESA mission to Jupiter—with 2 instruments from IRF.

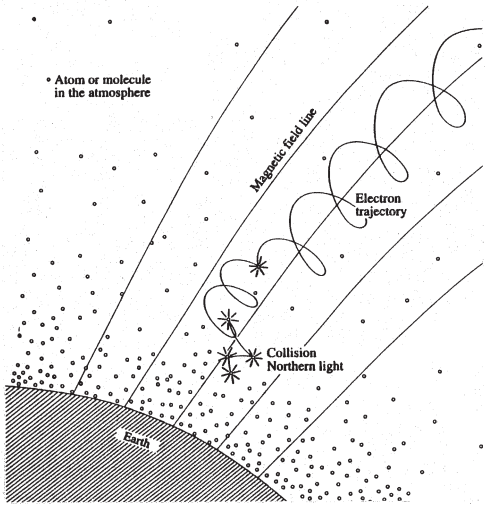
Space projects usually solve many questions but the results often give rise to new questions. This makes basic research (journeys of exploration into the unknown) even more exciting.

## Where do the Northern Lights originate?

The energy of the aurora or Northern Lights comes from the sun and is brought to the Earth by the solar wind. The solar wind plasma flows from the sun in all directions continuously, at an average speed of 400 km/s.

Part of the energy absorbed by the magnetosphere accelerates electrons (and ions). The electrons are directed by the Earth's magnetic field toward the polar regions.

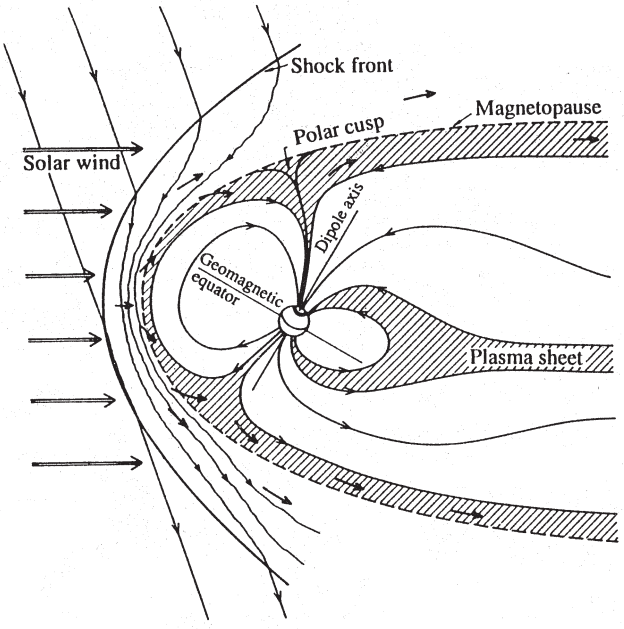
At a few hundred kilometers above the Earth, the electrons start colliding with particles in the atmosphere.The atmosphere is warmed up as some atoms, molecules and ions are excited, or absorb energy. The excess energy can be emitted as visible light—the Northern Lights. The colour of the Northern Lights depends on what kind of atoms or molecules are involved and on the level of excitation.




## Space Physics - understanding the universe

The universe is mainly composed of plasma (about 99%), which is an ionized gas capable of conducting electric currents. The Northern Lights are a result of physical processes in plasma. Plasma is affected by (and affects) electric and magnetic fields around planets, stars or even entire galaxies.

The magnetic field of the Earth varies greatly in certain areas during an "outburst" of aurora. Disturbances can affect power lines, telephone networks or radio communication.




## Ground-based research at IRF

Continuous measurements of the following are made at IRF:
- the magnetic field of the Earth
- northern lights
- cosmic radio noise
- ionospheric parameters

Experiments are conducted with research radars such as EISCAT (transmitters in Tromsø and on Svalbard). These are used to study processes including those which cause the aurora.

The three-dimensional structure of the aurora is studied with ALIS (Auroral Large Imaging System), a multi-station imaging system which uses tomographic reconstruction techniques, artificial intelligence and advanced IT. The system consists of a network of stations with advanced CCD cameras.

## Atmospheric research at IRF

IRF's atmospheric research focuses on studies of:
- ozone in the meso- and stratosphere
- strato- and mesospheric clouds
- strato- and mesospheric winds
- the coupling between different atmospheric layers (e.g. transport between the troposphere and the stratosphere)

Radar, optical methods, sounding rockets and balloons are used for atmospheric studies in the polar regions.

Continuous measurements are made of:
- atmospheric trace gases (including ozone)
- atmospheric winds
- infrasonic waves

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