Kwasan and Hida Observatories

Graduate School of Science Kyoto University

KWASAN AND HIDA OBSERVATORIES GRADUATE SCHOOL OF SCIENCE, KYOTO UNIVERSITY

The Kwasan and Hida Observatories belong to the Graduate School of Science of Kyoto University.

The Hida Observatory was founded in 1968 and is located in the Japanese Northern Alps. The clear skies and clean air in this region of Japan make this an ideal site for astronomical observations. The observatory has world class facilities, including high resolution telescopes such as the Domeless Solar Telescope, Solar Magnetic Activity Research Telescope, and 65cm refractor. These facilities allow us to carry out cutting edge astronomical research.

The Kwasan Observatory is 76 years old and now serves mainly as an educational center for undergraduate and graduate students. These students are trained in observational techniques, data analysis, and numerical simulations.

The two Observatories contribute to the progress of astronomical and space environmental science through education of students and the study of solar active phenomena and astrophysical plasmas. Furthermore, the facilities are open to use by students of other universities and high schools. For the public understanding of astronomy, we welcome visitors and inquiries. We also open our facilities to the general public on our Open Day every autumn.

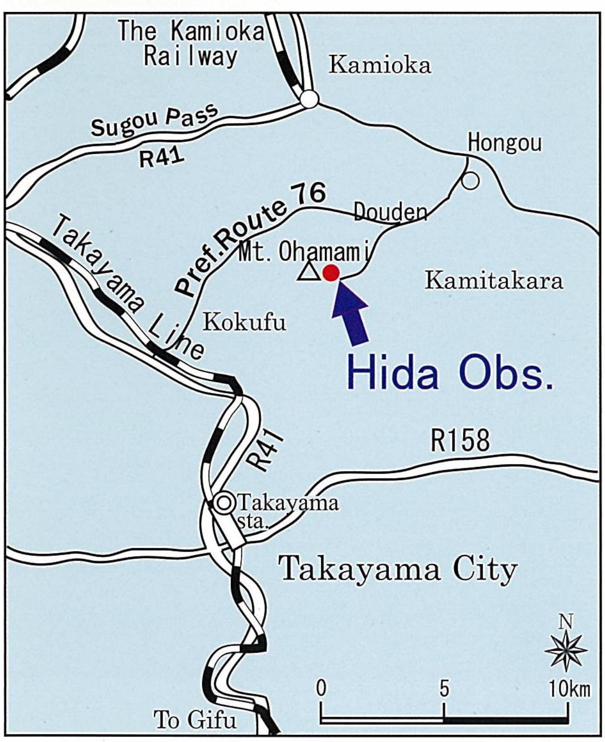
History

1929 Oct.	Kwasan Observatory was opened.
1960 Mar.	A 60cm reflector was installed.
1961 Mar.	The Solar Laboratory was completed including a horizontal solar telescope with 70cm Coelostat and high resolution spectrograph.
1968 Nov.	Hida Observatory was opened and the 60cm reflector was transferred to that location.
1969 Mar.	The 30cm Cook refractor was reformed with a 45cm Carl Zeiss lens at Kwasan Observatory.
1972 Apr.	The 65cm reflector, and dome were completed at Hida Observatory.
1979 May.	The 60 cm Domeless Solar Tower Telescope (DST) was completed at Hida Observatory.
1980 Mar.	A new building called a 'Shinkan' at Kwasan Observatory was completed.
1992 Mar.	The Solar Flare Monitoring Telescope (FMT) was completed at Hida Observatory.
1997 Mar.	A high resolution vector magnetograph was installed at the DST, and a spectrograph was installed in the focal plane of the 60cm reflector.
1999 Mar.	A new solar Hα imaging system was installed in the 18cm refractor at Kwasan Observatory.
2001 Mar.	A comprehensive repair of all buildings at Kwasan Observatory was completed. The Observatory History Museum was opened at Kwasan Observatory.
2003 Oct.	The Solar Magnetic Activity Research Telescope (SMART) came into service at Hida Observatory.
2004 Dec.	The tower cooling system of DST at Hida Observatory was renewed.

View of Hida Observatory

View of Hida Observatory

Anticlockwise from foreground to background you can see the Solar Magnetic Activity Research Telescope, the administration and accomodation building, the 60cm reflector dome and facilities, the Solar Flare Monitoring Telescope (small dome), the 65cm refractor dome, and the Domeless Solar Telescope.



Access to Hida Observatory

From JR Takayama Station

- Car (1 hour)
- Nohhi-bus service to "Douden"(1 hour)

Area information

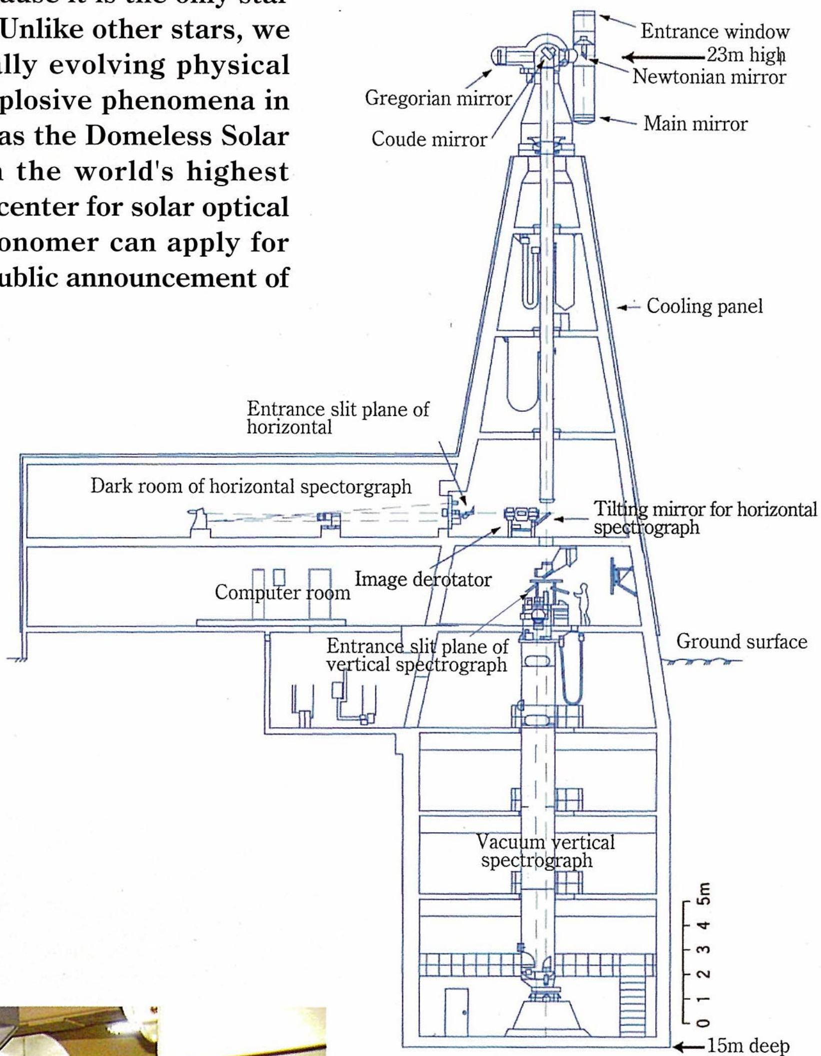
From Nagoya To Takayama,
through Tohkai-hokuriku Highway,
via Hida-Kiyomi IC.

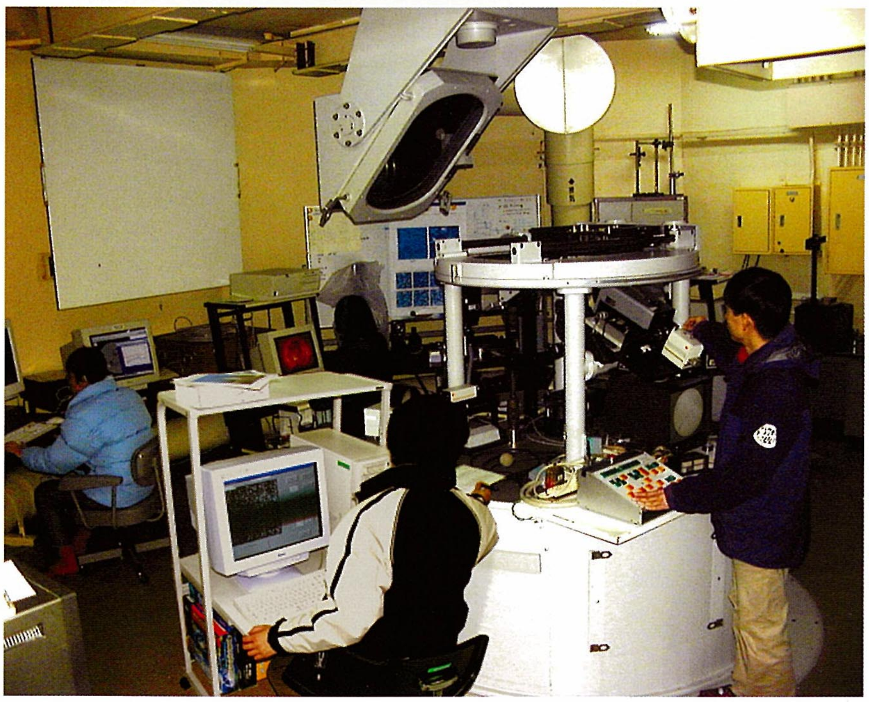
From Matsumoto,
drive to Kamitakara, via Aboh tunnel.

From Toyama
drive route 41 toward Kamioka.

Domeless Solar Telescope (DST)

The Sun is a unique celestial object because it is the only star whose surface we can spatially resolve. Unlike other stars, we can actually investigate the dynamically evolving physical structures and different high energy explosive phenomena in detail. To do this we use telescope such as the Domeless Solar Telescope. The DST is equipped with the world's highest resolution spectroscope, and is the main center for solar optical observations in Asia. Any visiting astronomer can apply for observing time with the DST through a public announcement of opportunity.





Observation with the high resolution vertical spectrograph which consisits of an imaging unit and the spectrum observation unit.

● Performance

Type	Domeless Tower Vacuum Telescope
Type	Gregorian type reflector telescope
Effective aperture	600mm
Focal length of objective mirror	3150mm
Total focal length	32.19m
Total F ratio	F/53.7
Resolution	0.18arcsec
The diameter of the solar image	299.95mm=1922arcsec
Tracking system	Photoelectric sensor
Pressure inside the vacuum tube	2-5mmHg
Telescope total weight	21tons

Violent Solar Active Phenomena

Jet-Type Hα Prominence

This is a photograph of a plasma jet ejecting from the solar limb. These jets can reach heights of 250,000km above the solar surface which is 20 times the size of the Earth! They travel at high speeds of 300 km/s. When these accelerated prominences are ejected towards the Earth, they can influence the Earth's magnetosphere and ionosphere.

Earth Size →

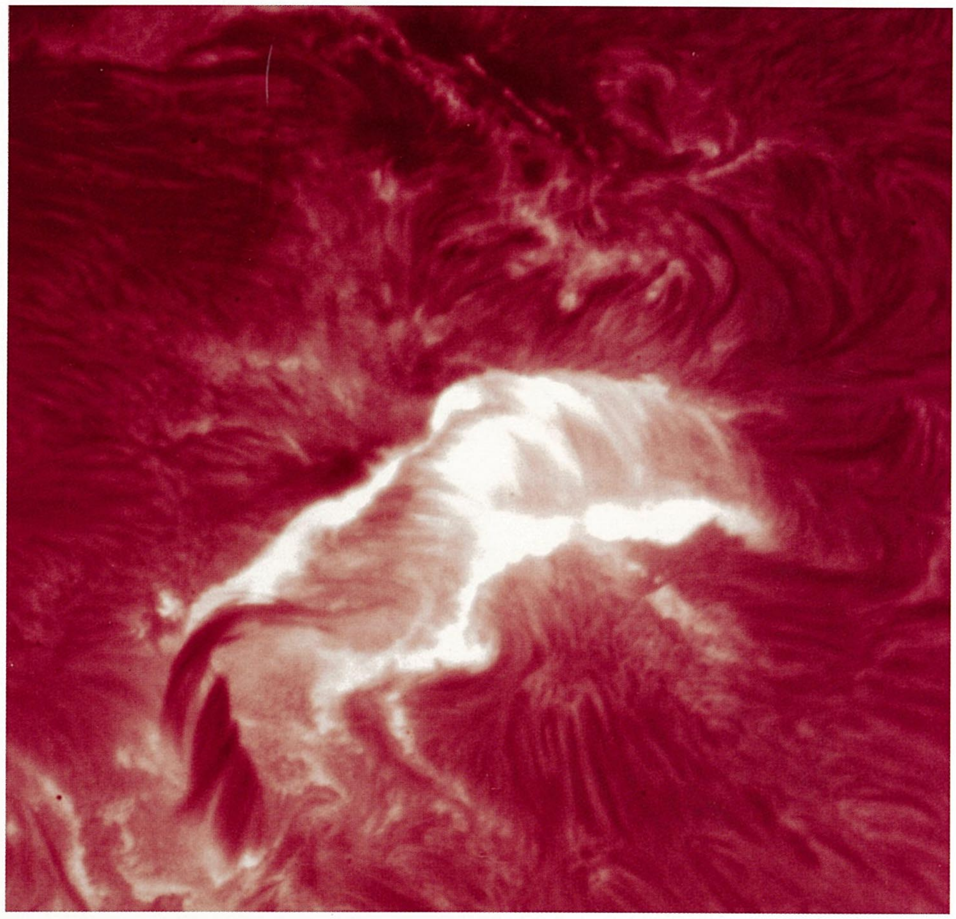
Jet-type prominences are believed to be produced by magnetic field reconnection. Detailed studies of this process works are expected to provide the key to unveiling other mysterious high-speed jet phenomena which occur in the universe. Therefore, we are studying this type of phenomena to understand all plasma jet phenomena in the universe.

A beautiful prominence which appeared on the solar limb.
It is thought that the gas in these prominences is supported by solar magnetic fields.

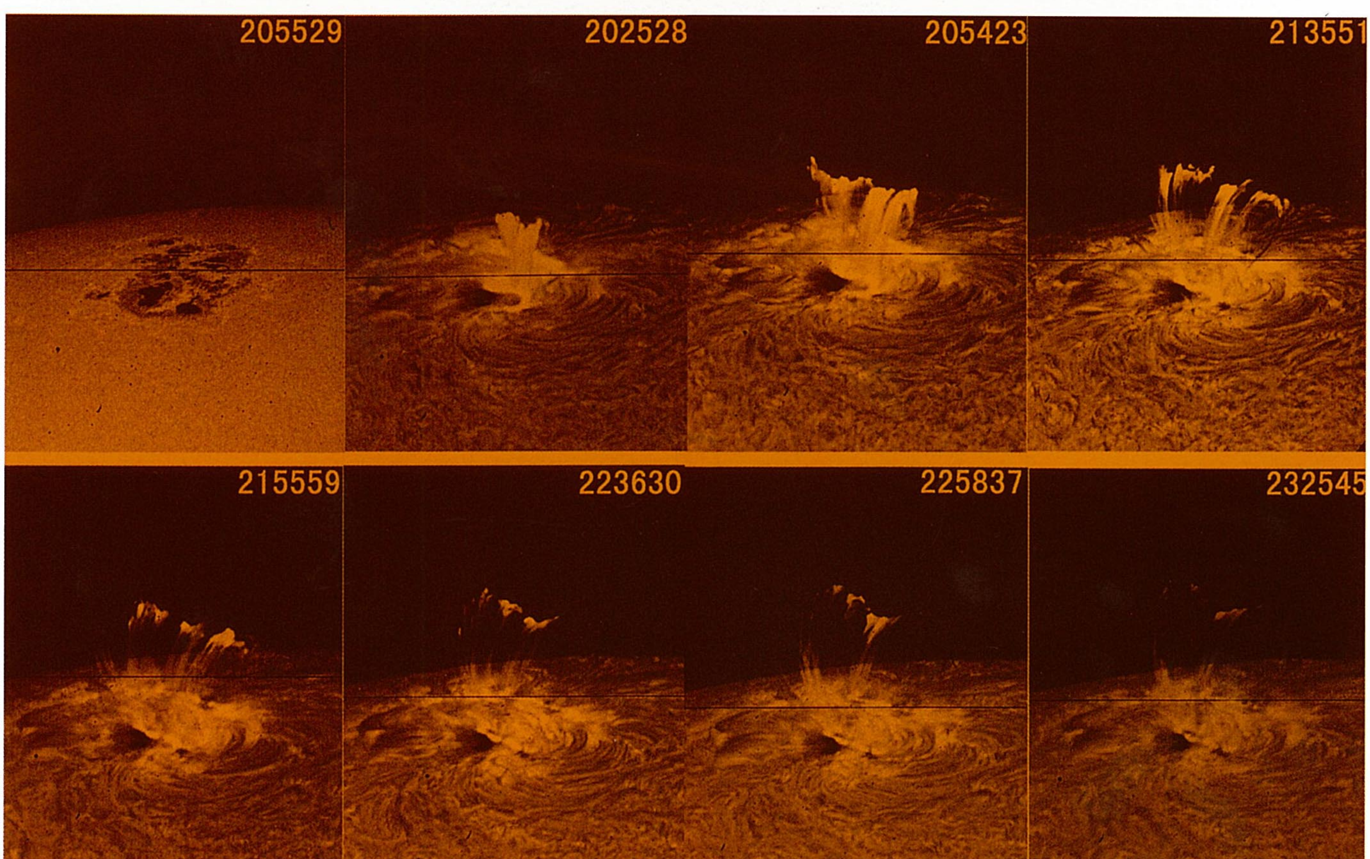
Solar Flare

In sunspot regions, large amount of magnetic energy are often released in a very short period (from a few seconds to a few minutes). This energy release produces plasma of super high temperatures and also produces high speed electron and proton beams, which emit hard X-rays and gamma rays.

How is this strong magnetic energy stored in the twisted magnetic fields of sunspots? How is it released so rapidly? One of our most important projects in astrophsics is to try to answer these questions.



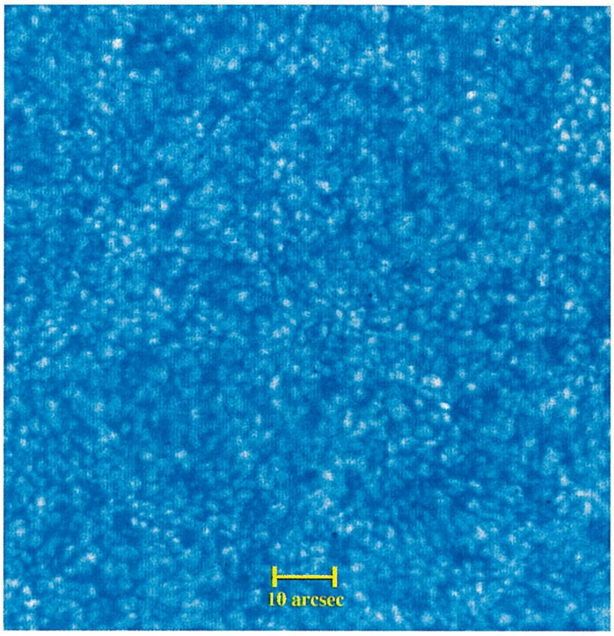
The Sun plays the role of a laboratory in which detailed observations of solar phenomena can be applied to understand the mechanisms of explosive phenomena in cosmic plasmas.



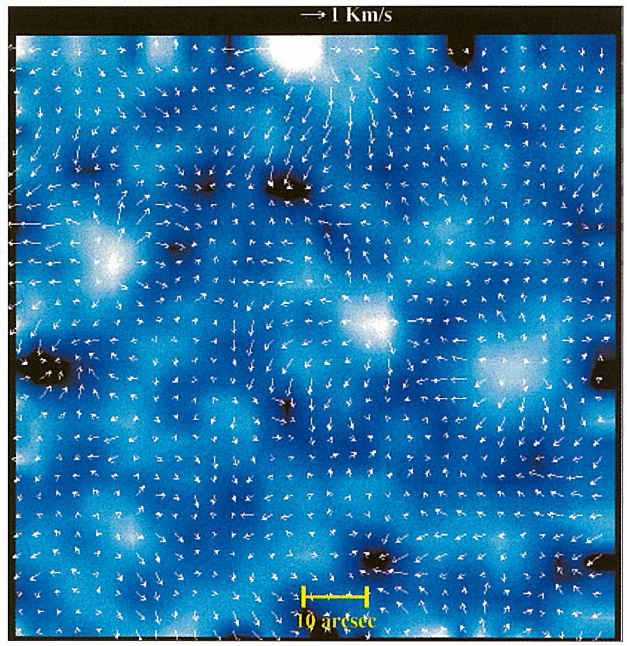
A solar flare occurring on the solar limb
You can see the high temperature plasma, which is trapped in magnetic loops,cooling and falling down.

Solar Convection Patterns

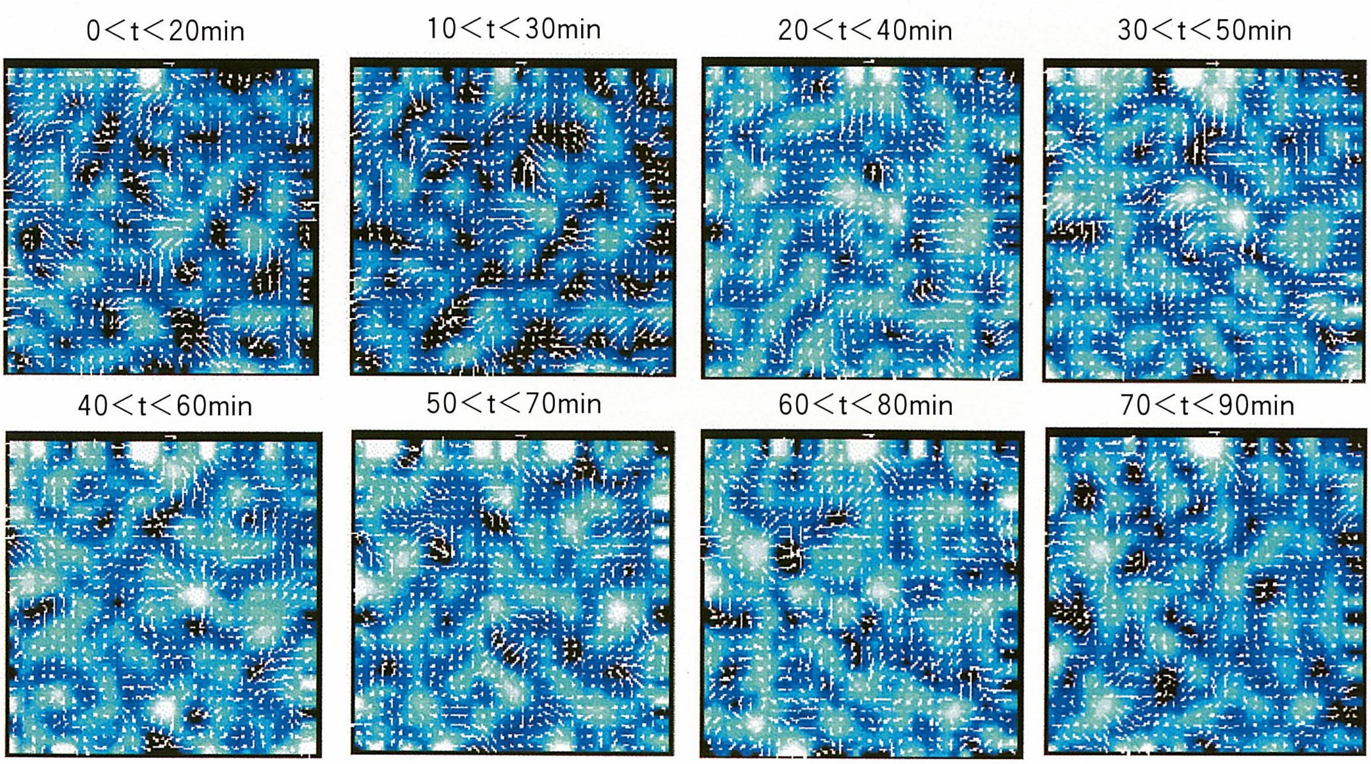
On the solar photosphere, we observe convective patterns of a variety of sizes, from granulation to super granulation. Convection beneath the Sun's surface is thought to store the energy that produces active phenomena through interactions with the magnetic field. Furthermore, convection is expected to be one of the driving mechanisms of the solar cycle, that is, the increase and decrease of total solar activity over a period of 11 years. However, no complete physical explanation has yet been established, and so long-term detailed observations are necessary to solve this problem.



Granulation:
the diameter is about 1 arcsec.
The bright patches are hotter and rising.



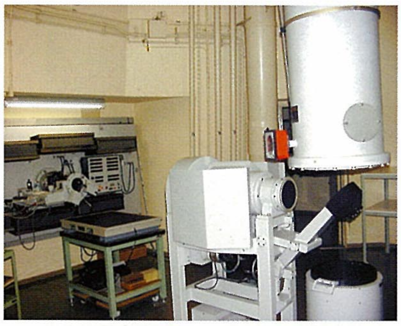
Meso-granulation:
the diameter is about 10 arcsec.
The arrows represent the direction of flows parallel to the solar surface. The bright and dark patches show the divergent and convergent motions, respectively.

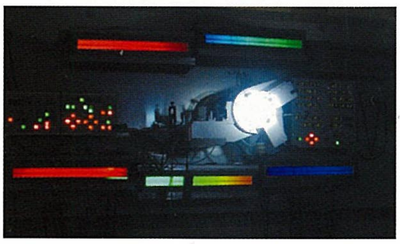


Snap shots of the structural evolution of the meso-granulation over 90 minutes

Spectroscopic Observations of the Sun

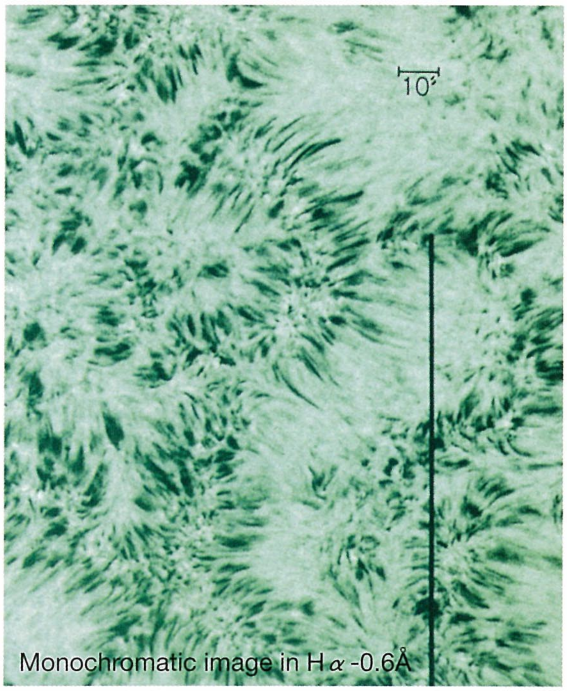
The vertical spectrograph of the Domeless Solar Telescope (DST) has a very high wavelength resolution, which competes with the best telescopes around the world. We use it to study the fundamental fine structure of the solar atmosphere, and the physical conditions in active phenomena on the solar surface.



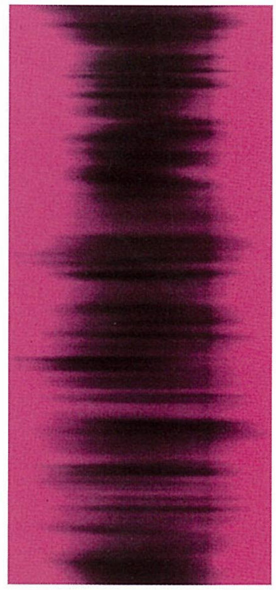


Observation with the horizontal spectrograph on the 2nd floor

▼The network structure of the chromosphere, and the Hα line spectrum of fine structures (obtained with the vertical spectrograph)

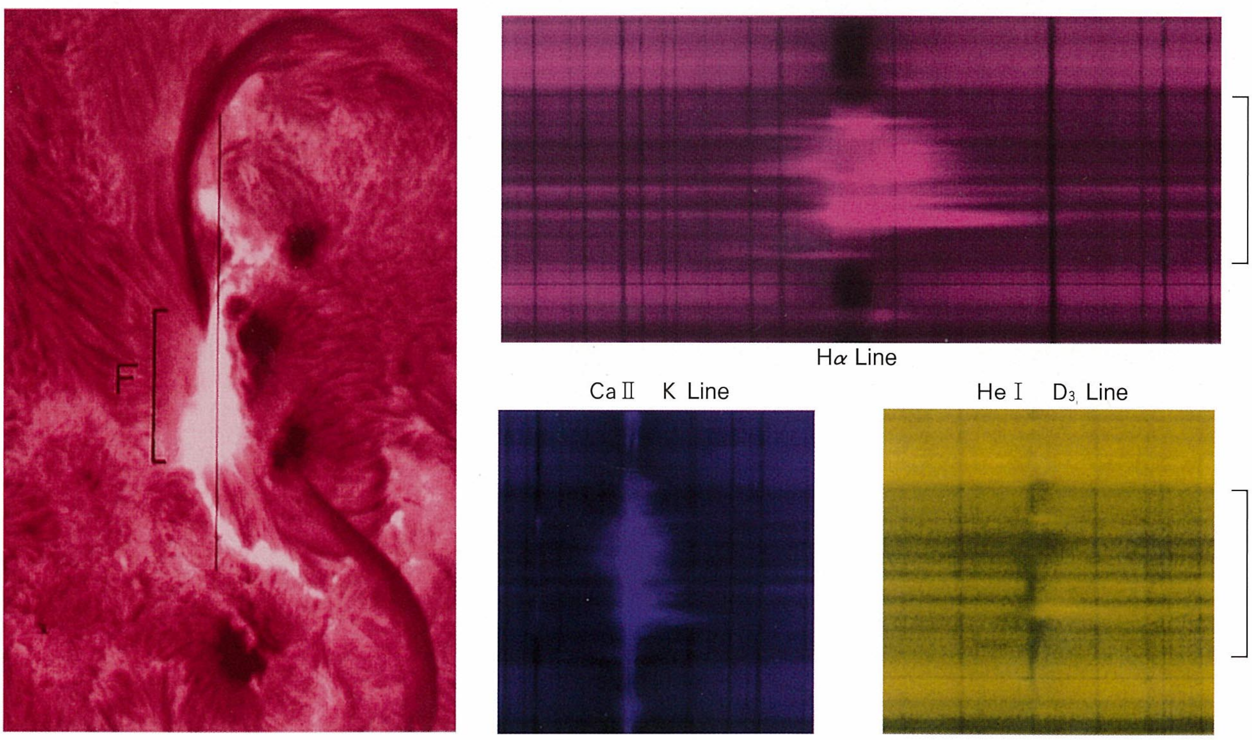


▼Hα absorption line spectrum



● Performance

	Horizontal Spectrograph	Vertical spectrograph
Type	Czerny-Turner	Czerny-Turner (evacuated)
Focal Length	10m	14m
Resolution	0.33Å/mm (2nd order)	0.11Å/mm (5th order)
Effective Wavelength range	3,600-11,000Å	3,600-11,000Å
Weight	3tons	10tons
Advantage	Simultaneous acquisition of all wavelengths	High resolution



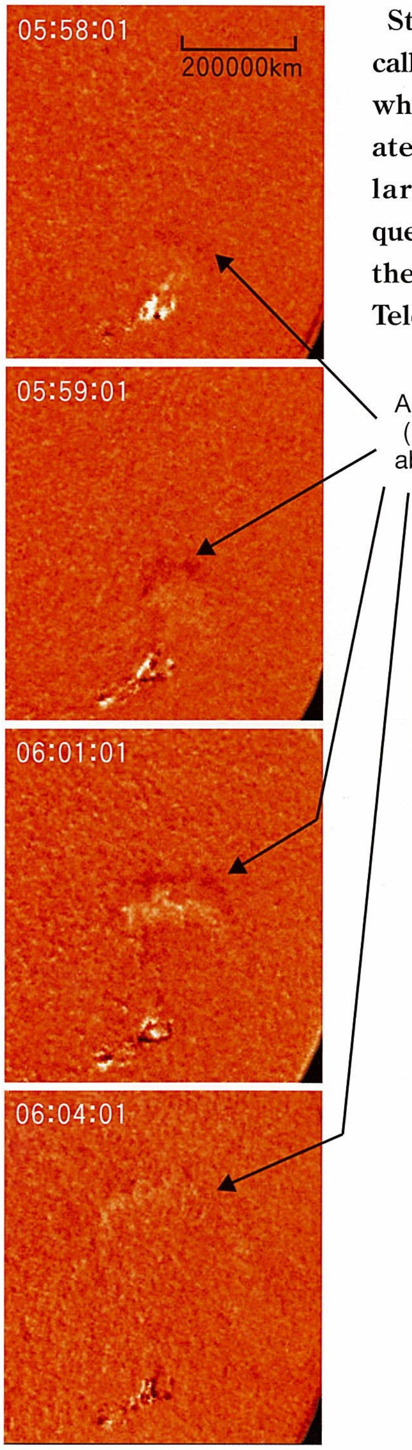
A high resolution spectrum of a solar flare (F)
The broadened and red-shifted Hα line indicates that the gas is descending with a velocity of about 100km/s.

Solar Flare Monitoring Telescope (FMT)

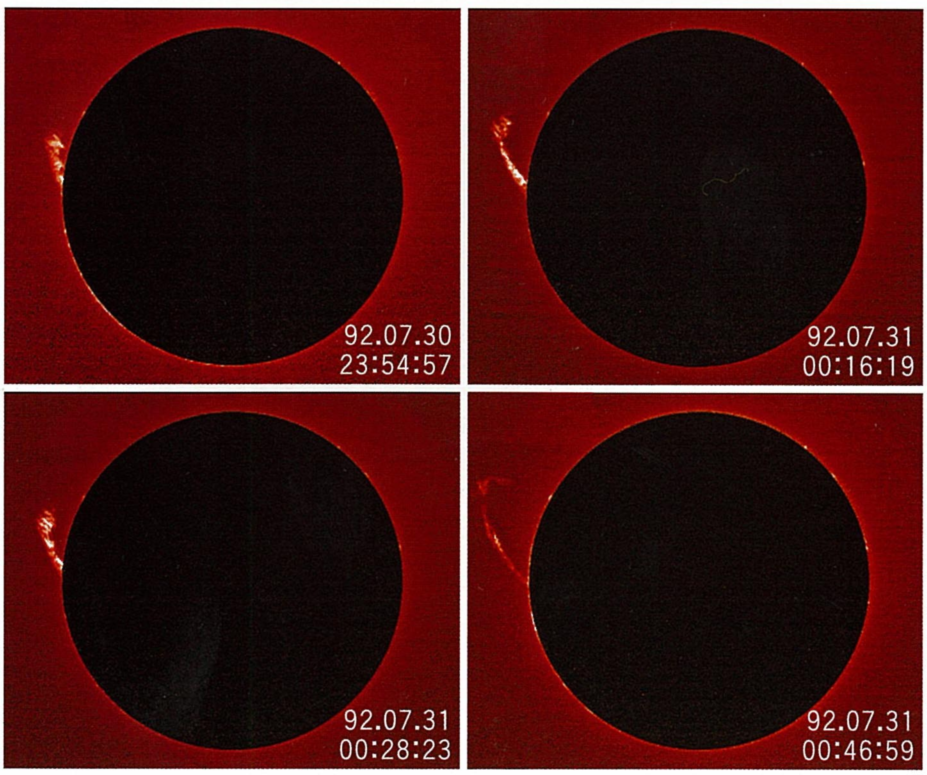
Strong solar flares and coronal mass ejections can seriously affect terrestrial communication systems and human activities in space. Therefore, continuous monitoring and forecasts of solar activity are necessary. The Solar Flare Monitoring Telescope (FMT) observes the entire solar disk every day at five different wavelengths.

The Solar Flare Monitoring Telescope and its 3m dome

Strong shock waves, called Moreton waves, which occur immediately after strong solar flares, are frequently discovered by the Flare Monitoring Telescope.



A Moreton wave (Propagation velocity is about 700 km/s)



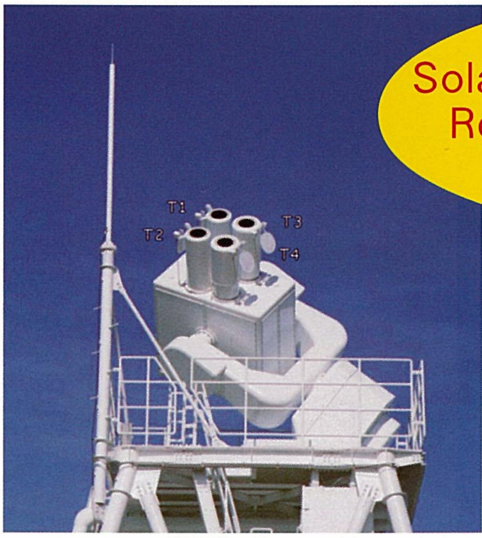
A large prominence eruption which occured on July 31, 1992
It erupted into interplanetary space after a gradual acceleration.These images show the first 50 minutes of this eruption.

Solar Magnetic Activity Research Telescope (SMART)

In our current space age, we need to protect satellite communications systems and ensure the safety of manned spaceflights. These activities will grow and become more important in the future. Therefore, it is becoming more and more important to forecast space weather by predicting the occurrence of flares and prominence eruptions on the Sun.

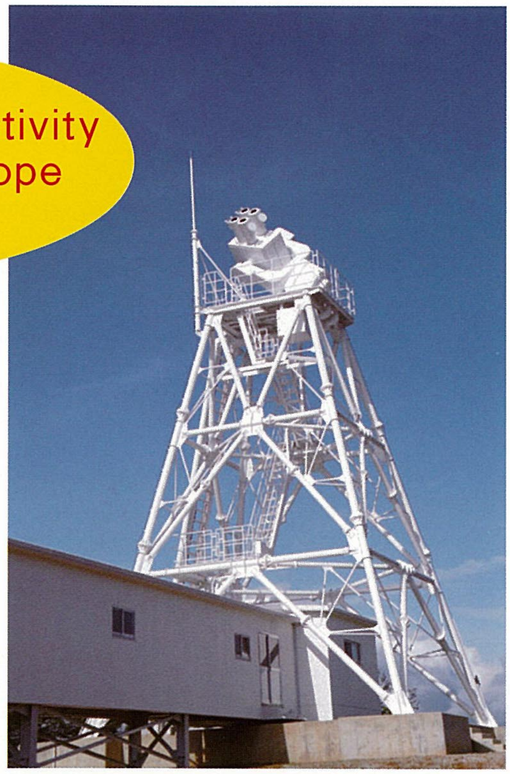
The Solar Magnetic Activity Research Telescope (SMART) was developed to study the mechanisms by which twisted magnetic fields accumulate and release the energy which causes strong solar flares. The SMART telescope allows us to simultaneously obtain the Hα full solar image and full solar vector magnetogram with the world's highest spatial resolution.

Solar Magnetic Activity Reseach Telescope (SMART)

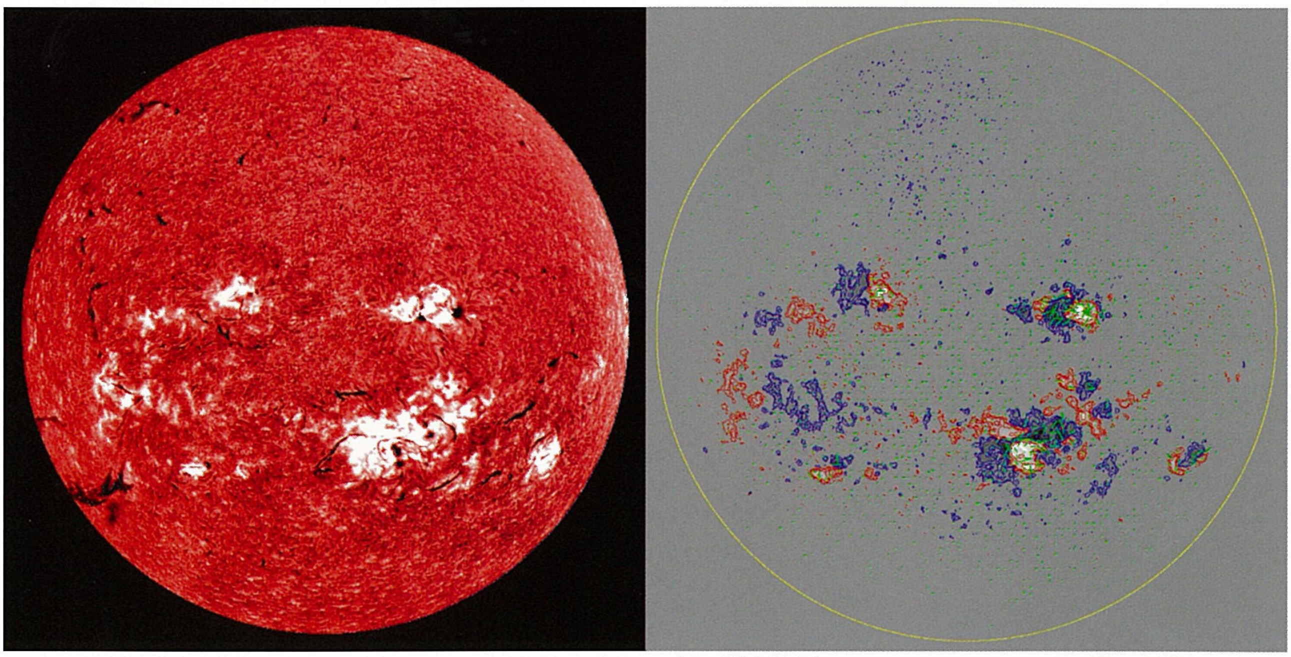


The Four Telescopes of SMART

SMART consists of four different telescopes with apertures of 20 or 25 cm. These telescopes are positioned on a 16m tower and have the following functions:
T1: Hα full disk observations
T2: Vector magnetic field measurements
T3: Hα high resolution observations of a selected 1/4 solar disk
T4: High-accuracy magnetic field observations



Solar Magnetic Activity Research Telescope (SMART)



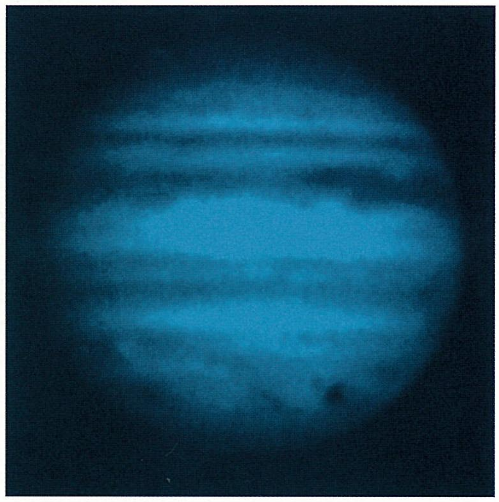
Images taken with SMART

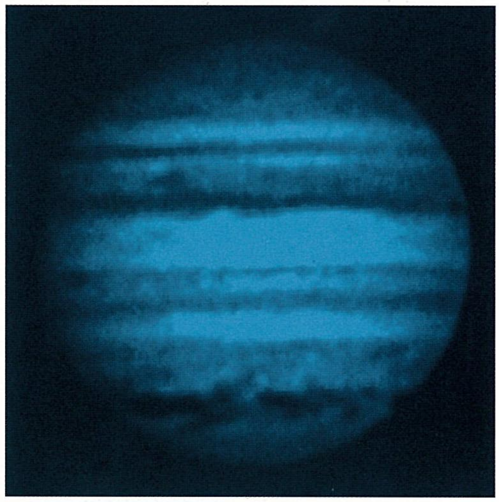
This figure shows full disk solar images taken by SMART on 30th October 2003.
Left : Hα image (using T1).
Right : Vector magnetogram (using T4). The red and blue contours represent the positive and negative polarities, respectively. The short green lines delineate the direction of the magnetic field lines.

65cm Refractor for Research of Solar System

In the excellent seeing conditions at Hida Observatory, the 65cm refractor allows us to observe the planets of the solar system. The telescope has a long focal length and high contrast lens, and has provided us with precious data from long-term continuous observations. It has contributed especially to our understanding of the seasonal variations of Mars' atmosphere and surface, and convective patterns in Jupiter's atmosphere.

Jupiter





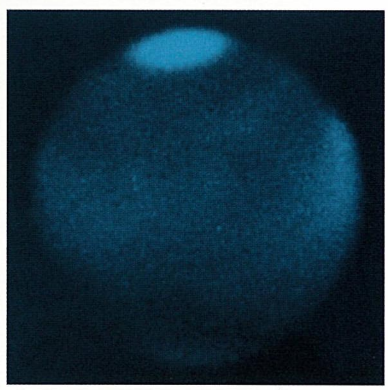
When comet Shoemaker-Levy impacted Jupiter in July 1994, trails of collision-induced clouds appeared at high latitudes in the Southern Hemisphere.
Top: Three days after the first impact of a comet fragment.
Bottom: After succesive impacts of the comet fragments over a week, the elongated trails overlapped and finally formed a single strip.

● Performance

Aperture	650mm
Focal length	10,500mm
F/ratio	16
Resolution	0.18arcsec
Light gathering power	8600
Limiting visual magnitude	16.2
Tracking accuracy	0.1arcsec/9min
Size of the housing	930mm ϕ × 11,500mm
Total weight	17tons

Mars

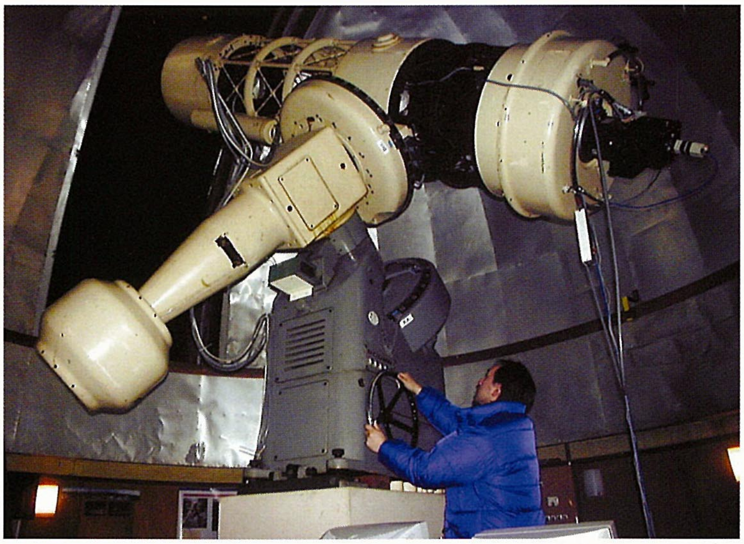
Red filter (6000Å)

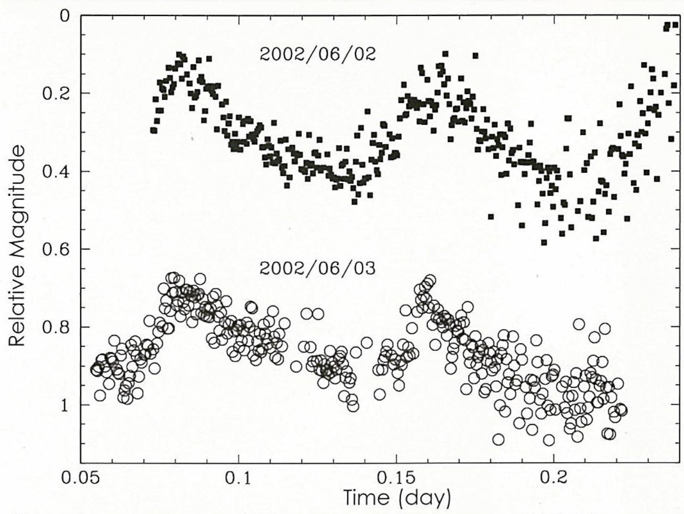


Blue filter (4000Å)

Spring in the Martian Northern Hemisphere
A large Northern polar cap was clearly seen in the blue color filter

60cm Reflector





Superhumps in a cataclysmic variable named "QW Serpent" observed with the 60cm reflector. The superhumps are light modulations with an amplitude of 0.3 magnitudes and a period of 111 minutes.

Comet

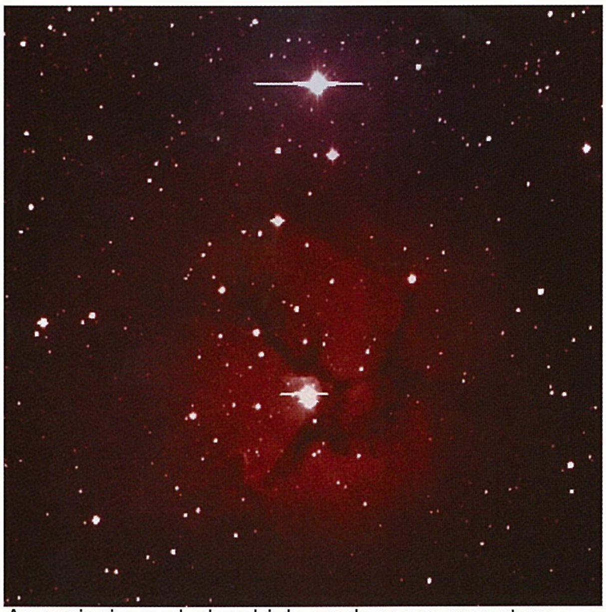
Comet "West" rising over the Northern Alps and showing a splendid trail

● Performance

Aperture	600mm
Focal length	3300mm (Newton focus: Main focus) 12000mm(Cassegrainfocus)
F/ratio	5.5 (Newton focus) 20.0 (Cassegrain focus)
Resolution	0.19arcsec
Light gathering power	7400
Limiting visual magnitude	19.5
Tracking accuracy	1.5arcsec/min
Size of the housing	860mmϕ × 3,700mm
Total weight	4.5tons

Nebula

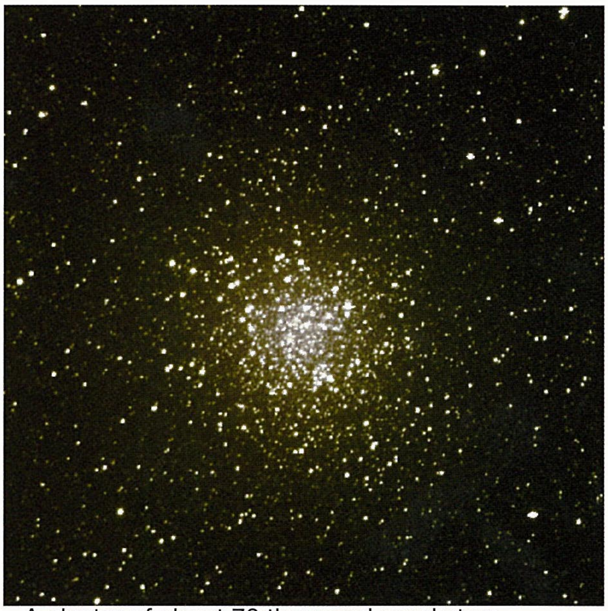
Trifid Nebula in Sagittarius



An emission nebula which produces young stars

Star Cluster

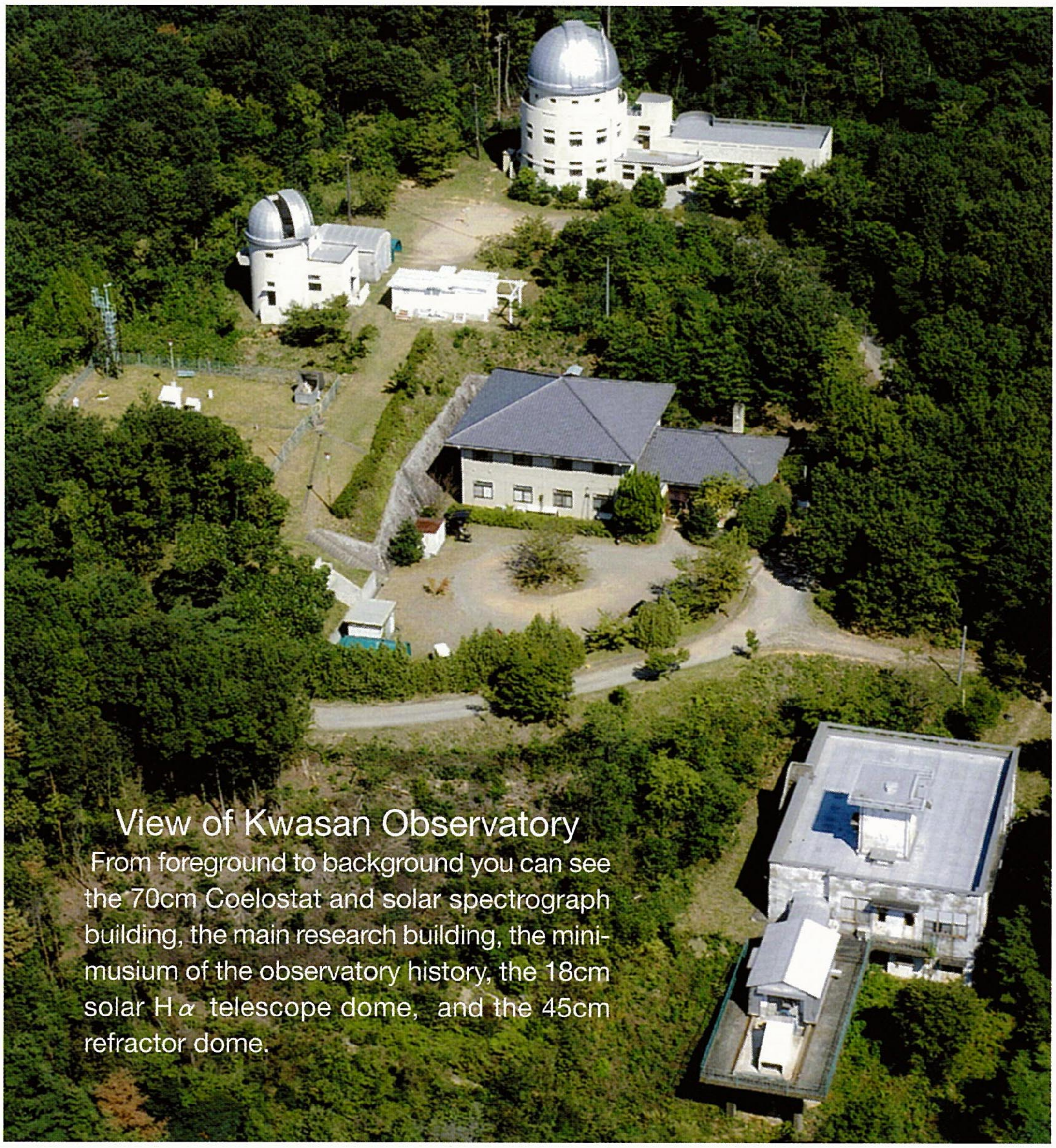
M22 Globular Cluster



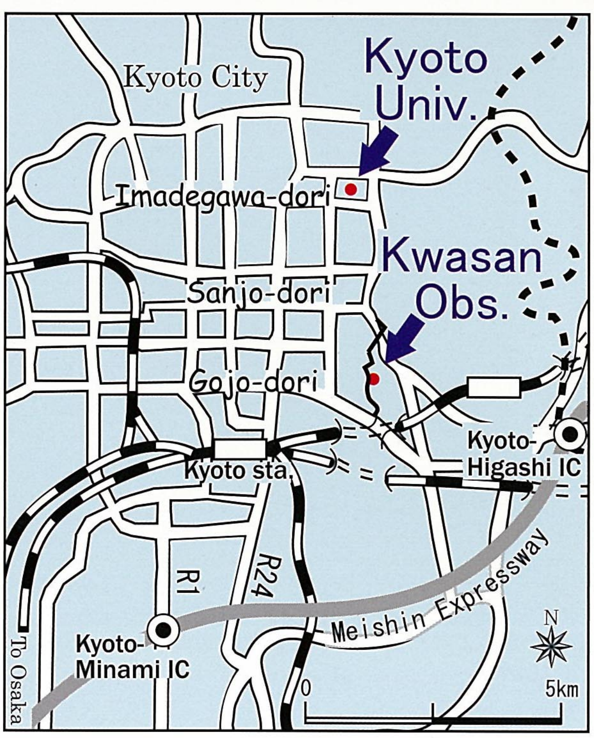
A cluster of about 70 thousand aged stars

Images taken with the CCD camera
The camera was cooled with liquid nitrogen and attached to the main focus.

View of Kwasan Observatory



View of Kwasan Observatory
From foreground to background you can see the 70cm Coelostat and solar spectrograph building, the main research building, the mini-musium of the observatory history, the 18cm solar Hα telescope dome, and the 45cm refractor dome.



Access to Kwasan Observatory

From JR Kyoto Station
Taxi (20 minutes)
From Subway Keage Station.
- Taxi (5 minutes)
- On foot (45 minutes)

Observatory Office at the North Campus, Kyoto University.

From JR Kyoto Station.
- Municipal bus service 17.
  Get off at "Kyodai Nohgakubu-mae" Stop (45 minutes)
- Taxi (20 minutes)

From Keihan Demachi-yanagi Station.
On foot (15 minutes)

Kwasan Observatory

Kwasan Observatory has contributed to the development of astronomy since its foundation in 1929. Its main contributions have been in the areas of education, research, and observation of the Sun, Moon, and planets. They are the closest and the most important celestial objects for Earth.

Recently, Kwasan Observatory focuses particularly on the research of solar and stellar active phenomena. It also serves as an integrated data analysis center, incorporating observations obtained at the Hida Observatory, and by satellites such as Yohkoh, SOHO, and TRACE. The observatory is also used for the curriculum of undergraduate and graduate students: observations, data analysis, and their practical training. In addition, we provide students of other universities and high schools with the opportunity for observational exercises in astronomy .

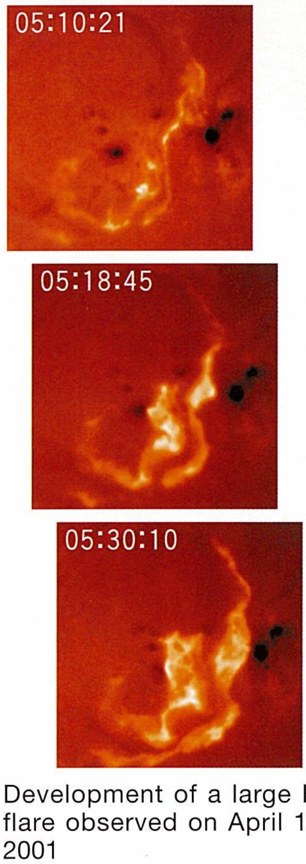
The Kwasan Observatory 45cm refractor building

Observing the Sun

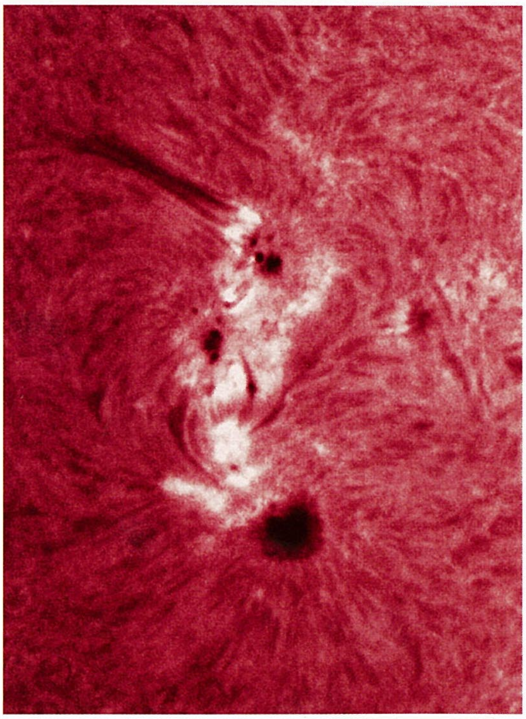
The Sun is unique in that we can observe dynamic and active phenomena on its surface in detail, unlike other stars. Therefore, the Sun is sometimes referred to as "A laboratory for magnetized space plasmas".

We can see the energetic activities of magnetic plasma on the solar surface using, for example, a narrow band filter that only transmits light in the Hydrogen alpha line.

Hα monochromatic imaging system Sartorius 18cm refractor with a Lyot filter (band width: 0.5Å) and a CCD camera.



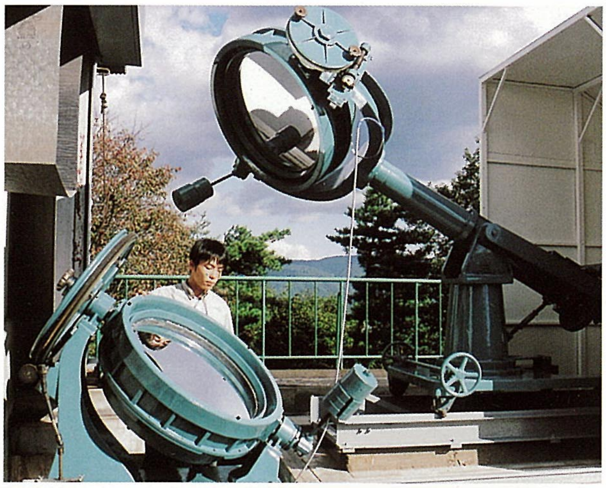
Development of a large Hα flare observed on April 10th 2001



The Flare and jet eruption occurred in a sunspot group

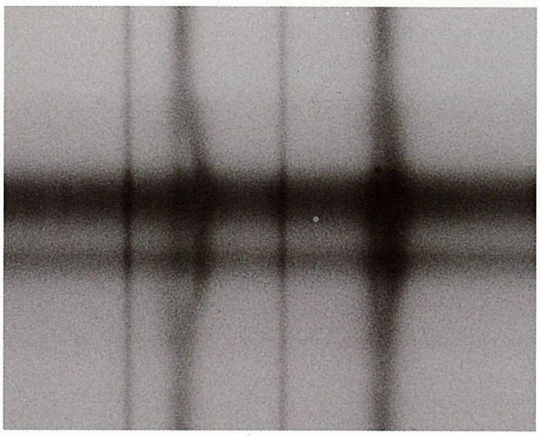
Observational Exercises for Graduate and Undergraduate Students

Observing the solar spectrum



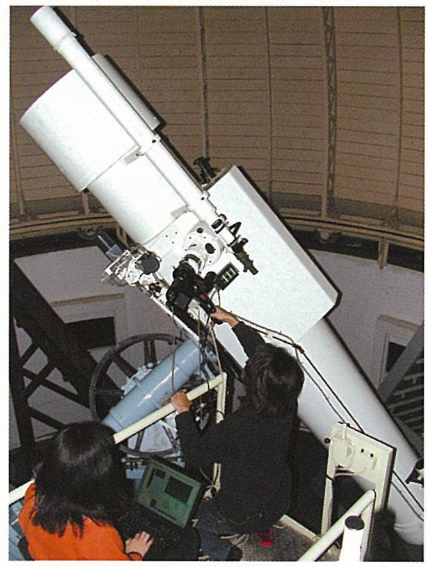
70cm coelostat

Observing the solar spectrum using a CCD camera in the darkroom



Spectral lines (FeI6302Å) split by the Zeeman effect, with which we can measure the strength of the magnetic field in the sunspot.

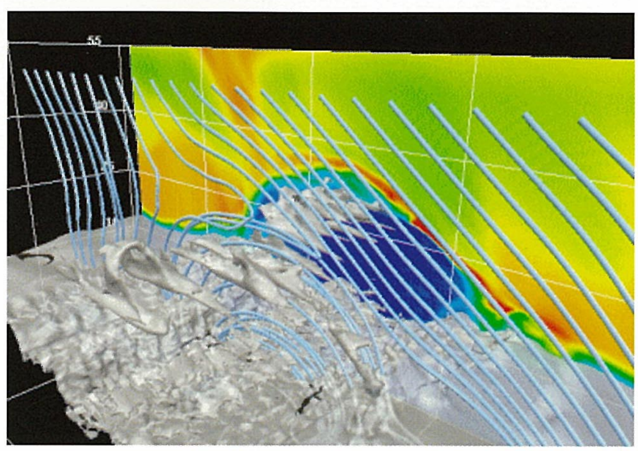
Observing the planets using the 45cm refractor with a CCD camera



Data Analysis and Numerical Simulation

We analyze extensively the multiwavelength data obtained by various solar telescopes (like those at Hida Observatory) and X-ray and extreme ultraviolet satellites (such as Yohkoh, SOHO and TRACE), with advanced computer systems. These systems are also used for numerical simulations of solar magnetohydrodynamics.

Equipment for data analysis and numerical simulations



A numerical simulation result of filament formation and jet eruption associated with emerging flux. The gray surface is the iso-surface of the mass density, the color on the far surface is the temperature distribution, and the blue tubes are the representative magnetic field lines, respectively.

Comet "Hale-Bopp" in the sunset, observed at the Hida Observatory in March 1997

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Observatory's Office
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