CHAPTER 2

Instrumentation, Observations and Data Reduction

2.1 The Solar and Heliospheric Observatory (SOHO)

The Solar and Heliospheric Observatory (SOHO), is a project of international cooperation between ESA and NASA to study the Sun, from its deep core to outer corona. It is probably the most comprehensive and complex solar space mission after the Skylab. The SOHO is a three axis stabilized spacecraft that constantly faces the Sun. Its design is based on a modular concept with two main elements: the payload module, housing the 12 instrument packages, and the service module, providing essentials such as thrusters, power and communications. The SOHO moves around the Sun in steps with the Earth, by slowly orbiting around the First Lagrangian Point (L1), where the combined gravity of the Earth and Sun keep the SOHO in an orbit locked to the Earth-Sun line. The L1 point is approximately 1.5 million kilometers away from the Earth (about four times the distance of the Moon), in the direction of the Sun. The specific positions of the SOHO give it an uninterrupted view of the Sun. The scientific payload of the SOHO comprises 12 complementary instruments, developed and furnished by 12 international consortia involving 29 institutes from 15 countries. Nine consortia were led by European scientists, the remaining three by US scientists. The instruments on board SOHO are: Coronal Diagnostic Spectrometer (**CDS**), Charge, Element, and Isotope Analysis System (**CELIAS**), Comprehensive Superthermal and Energetic Particle Analyzer (**COSTEP**), Extreme ultraviolet Imaging Telescope (**EIT**), Energetic and Relativistic Nuclei and Electron experiment (**ERNE**), Global Oscillation at Low Frequencies (**GOLF**), Large Angle and Spectrometric Coronagraph (**LASCO**), Michelson Doppler Imager /Solar Oscillation Investigation (**MDI**/**SOI**), Solar Ultraviolet Measurements of Emitted Radiation (**SUMER**), Solar Wind

Anisotropies (**SWAN**), and UltraViolet Coronagraph Spectrometer (**UVCS**). In this thesis we have used the data from the following instruments on board SOHO.

A. SOHO/MDI

Magnetic fields are of fundamental importance in the physics of the solar flares. In our study the magnetogram data from SOHO/ Michelson Doppler Imager (MDI) (Scherrer et al., 1995) are used to understand the magnetic field complexity of the solar flares. The MDI obtains high quality synoptic observations of the full-disk line-of-sight magnetic field, free from atmospheric distortions. The MDI can observe in either of two spatial resolutions, as selected by the shutter. The full disk path has a field of view of 34’ x 34’ and 4” resolution with a cadence of 95 minute. The high resolution path is magnified by a factor of 3.2 to provide 1.25 resolutions over an 11’ x11’ field of view with a cadence of 1 minute. The detector system employs a passively cooled 1024 x1024 pixels CCD that is read out at 50000 pixels per second.

B. SOHO/EIT

The Extreme-Ultraviolet Imaging Telescope (EIT) is designed to provide full-disk images of the solar transition region and the inner corona upto 1.5 R (Delaboudiniere et al., 1995). Its normal incident multilayer-coated optics select the spectral emission lines from Fe IX (171Å), Fe XII (195Å), FeXV (284Å) and He II (304Å) to provide sensitive temperature diagnostics in the range from 6×10^4 K to 3×10^6 K. This telescope has a 45' x 45' FOV and 2.6" pixels which provide about 5" spatial resolution. The primary scientific objective of the EIT is to study the dynamics and evolution of coronal structures over a wide range of time scales, size and temperatures to bring new coronal heating and solar wind accelerations.

C. SOHO/LASCO

To study the CMEs associated with studied flares we used the Large Angle Spectroscopic Coronagraph (LASCO) (Brueckner et al. 1995) data. The short description about this is described in following sections: The LASCO is a three Coronagraph package, which has been jointly developed for the SOHO mission by the Navel Research Laboratory (USA), the Laboratorie d Astronomie Spatial (France), The Max Plank-Institude fur Aeronagraphs (Germany) and the University of Birmingham (UK). LASCO comprises three coronagraphs C1, C2 and C3 that takes the images of solar corona from 1-30 solar radii (C1: 1.1-3 R_S, C2: 1.5-6 R_S and C3: 3.7-30 R_S). The C1 coronagraph is a newly developed mirror version of classic internally-occulted Lyot coronagraph, while C2 and C3 coronagraphs are externally occulted instruments.

The brief summary of the LASCO is summarized in Table 1.2.

Table 1.2: LASCO C1, C2 and C3 details

Coronagraph	FOV R	Occulter Type	Spectral Bandpass	Objective Element	Pixel Size
C1	1.1-3.0	Internal	Fabry – Perot	Mirror	5.6
C2	1.5-6.0	External	Broadband	Lens	11.4
C3	3.7-30	External	Broadband	Lens	56.0

2.2 Nobeyama Radioheliograph

The Nobeyama Radio Heliograph (NORH) is a Japanese interferometric array which observes the Sun in two frequencies, 17 and 34 GHz; from 22:00 to 6:00 UT .The generated maps can have a spatial resolution of ~ 10 arcsec and a time resolution of 1 sec. **The Nobeyama Radio Observatory** (NRO) is a division of the National Astronomical Observatory of Japan (NAOJ) and consists of three radio instruments located in Nobeyama, a village in the Japan Alps at an elevation of 1350m. It is 45m single-dish radio telescope that operates in short-millimetre wavelengths and a millimetre interferometer consisting of six 10m diameter telescopes. The Nobeyama Radioheliograph An array of eighty-four antennas dedicated for solar observations.

Figure 2.2: Nobeyama 45m single-dish radio telescope.