

Chapter 1

Introduction

1.1 Introduction

The gas and dust between stars, called the “interstellar medium”, marks the location of star-forming regions (SFRs) in the Galaxy. Half of the interstellar medium is cold molecular gas, found in dense clouds and occupying only 1 percent by volume of the total interstellar medium. In these clouds there are interstellar molecules such as hydroxyl radical (OH), carbon monoxide (CO), methane (CH₄), and ammonia (NH₃) which are studied through their radio emission (including mm-wave lines). Stars form within these dense molecular clouds.

Astronomers suggest that giant molecular clouds play a key role in the process of star formation which probably proceeds like this: a star forms in the gravitational collapse of a part of a rotating molecular cloud; the central part gathers into the protostar, which appears as an infrared source surrounded by a dense disk. Next, the star develops a powerful wind that breaks through the disk in opposite directions. The wind carries along clumps of molecular material and strikes the cloud, producing shock waves. This feature is called “bipolar outflows”. The best known theoretical models and ideas are those of Pudritz & Norman (1986), and Uchida & Shibata (1985). They suggest that bipolar outflows basically involve a disk of materials around the protostar, threaded with magnetic field. The disk forms from gravitational contraction with angular momentum. The magnetic field resides in the surrounding molecular cloud. Ionized gas that falls into the disk drags the magnetic field with it. The hot disk generates both a molecular flow (from the outer region) and an ionized flow from its inner parts. The ionized outflow is channeled by the magnetic field. Astronomers believe that magnetic field in accretion disks have a crucial role in producing the outflows or jets observed in many protostellar objects. In turn, the outflows appear to be associated with the birth of a star.

In the case of massive young stars, they ionize their surroundings to produce HII regions. These regions are found within molecular clouds, and gradually become visible to optical telescopes as they destroy more and more of the surrounding dust and molecules. The HII regions expand because they are much hotter than the surrounding cold gas and so have much higher gas pressure. The expansion of an HII region sweeps up the surrounding molecular gas and compresses it. Therefore, the clumps of excited molecular materials called “masers” are often found in this region. OH masers are excellent indicators of star formation since they are associated with ultracompact HII regions and bipolar molecular outflows from a young star. OH ground state masers at 18 cm wavelength exhibit strong circular polarization due to Zeeman splitting. The implied magnetic field strength is typically a few mG, which is sufficient for the field to be dynamically important. The interferometric techniques are required to study structure of star-forming region. Because of the star-forming regions require higher spatial resolution to directly demonstrate the effect, and to explore the homogeneity of the magnetic field within the star-forming regions.

1.2 Literature Review

There are many observations of the OH masers in the star-forming regions. The Multi-Element-Radio-Linked-Interferometer-Network (MERLIN) is one of the largest interferometer network in northern hemisphere. OH masers in the bipolar outflow W75N were studied by using MERLIN polarization measurements of 1665- 1667- and 1720-MHz (Hutawarakorn et al., 2002). The distribution is interpreted in terms of a rotating disc orthogonal to the bipolar outflow and the compact cluster of OH masers spread appears to mark the source of the outflow. The field strength measured from Zeeman pairs of opposite circular polarization ranges from -8 to 8 mG, with the field reversal on opposite sides of the disc. This is interpreted in term of a toroidal component of the magnetic field in the disk, support to the twisted magnetic field model originally proposed by Uchida & Shibata (1985). Gasprong et al. (2002) also shows that the OH

masers in G34.3+0.2 lie systematically close to the HII region and the magnetic field strength of typically 5 mG. In the southern hemisphere, the surveys of OH masers in the star-forming regions were done by Caswell (1998). However, the only OH masers source which has been mapped by using interferometer is OH 323.459-0.079 (Caswell & Reynolds, 2001). The observation of the 1665- and 1667-MHz yielded a series of maps, in right - and left hand circular polarization, with tenth-arcsec spatial resolution. The Zeeman splitting derived the value of the magnetic field and (central) kinematics velocity. Magnetic field estimates range from +1.47 to +4.13 mG with the median value of +2.5 mG. The magnetic field strengths measured range from 2 to 8 mG, which sufficient for the magnetic field to play an important role in the source dynamics and evolution. This thesis proposes to study OH masers in the star-forming region in southern hemisphere OH 330.953-0.182. The OH 330.953-0.182 has the coordinates (J2000) RA $12^h 34^m 53.^s5$ and Dec $-51^\circ 54' 54.0''$. The single-dish observation in 1665 and 1667 MHz made by Caswell (1998) show this source is likely strong extended HII region, may be only loosely related to the masers, and could obscure any weaker compact HII region more directly associated.