Massive stars are thought to end their lives as supernova explosions. However, the explosion mechanism is not yet clear. Recent numerical simulations suggest that multi-dimensional effects are critical for successful explosions. In contrast, it is not easy to study the multi-dimensional shape of supernovae observationally, since supernovae in external galaxies are point sources (Figure 1).

In this study, we focus on spectropolarimetric observations, which are sensitive to multi-dimensional shape of the sources. We have performed multi-dimensional radiative transfer simulations and found following. (1) If the supernova explosion is completely axisymmetric, the spectropolarimetric data should align in the Stokes $QU$ diagram. (2) If the supernova explosion has a 3D, clumpy structure, the data in the $QU$ diagram show a loop. Based on these expectations, we have performed spectropolarimetric observations of extragalactic supernovae using Subaru/FOCAS.

As a result of spectropolarimetric observations [1], we found that the data show a loop in the $QU$ diagram as shown in Figure 2. This is consistent with the expectation of a 3D, clumpy explosion. By combining our new results with our past observations [2,3] and the data taken by other groups, we found 5 supernovae out of 6 objects show a similar pattern. This indicates that supernova explosion generally has a 3D, clumpy structure. Such a structure may be formed by the convection during the explosion. Our results can be an important key to understand the explosion mechanism from actual observations.

![Figure 1: Optical image of SN 2009mi in IC 2151 (the position of the supernova is pointed by the lines).](image)

![Figure 2: Spectropolarimetric data of SN 2009jf taken with Subaru/FOCAS. The data are plotted in the Stokes $QU$ diagram. Different colors represent different wavelength (Doppler velocities). The observed data suggest 3D, clumpy structure of supernova ejecta.](image)

**References**