Doctoral Dissertation Evaluation Review

Degree requested Doctor of Science Applicant's name Kazuhiro Shima

Examiner :
Chief examiner Visiting Associate Professor Elizabeth J. Tasker
Associate examiner Special Appointed Professor Asao HABE
Associate examiner Special Appointed Professor Takashi Kozasa
Associate examiner Professor Tatsuo Kobayashi
Associate examiner Lecturer Takashi Okamoto

Title of Doctoral Dissertation

The effect of photoionization feedback on star formation in giant molecular clouds
（分子雲における輻射が星形成に与える影響）

Results of Evaluation of the Doctoral Dissertation (Report)

Recently, the studies on star formation in molecular clouds are being actively done in Astrophysics. However, how massive star formation proceeds in molecular clouds is still unknown.

In this study, the author investigated the effect of photoionizing feedback inside turbulent star-forming clouds, comparing the resultant star formation in both idealized profiles and more realistic cloud structures drawn from a global galaxy simulation. The author performed a series of numerical simulations that compared the effect of star formation alone, photoionization and photoionization plus supernovae feedback. In the idealized cloud, photoionization suppresses gas fragmentation at early times, resulting in the formation of more massive stars and an increase in the star formation efficiency. At later times, the dispersal of the dense gas causes the radiative feedback effect to switch from positive to negative as the star formation efficiency drops. In the cloud extracted from the global simulation, the initial cloud is heavily fragmented prior to the stellar-feedback beginning and is largely structurally unaffected by the late injection of radiation energy. The result is a suppression of the star formation. We conclude that the efficiency of feedback is heavily dependent on the gas structure, with negative feedback dominating when the density is high.

Next, the author investigate star formation occurring in idealized giant molecular clouds, comparing structures that evolve in isolation versus those undergoing a collision. Two different collision speeds are investigated and the impact of photoionizing radiation from the stars is determined. the author find that a colliding system leads to more massive star formation both with and without the addition of feedback, raising overall star formation efficiencies (SFE) by a factor of 10 and steepening the high-mass end of the stellar mass function. This rise in SFE is due to increased turbulent compression during the cloud collision. While feedback can both promote and hinder star formation in an isolated system, it increases the SFE by approximately 1.5 times in the colliding case when the thermal speed of the resulting H II regions matches the shock propagation speed in the collision.

In conclusion, the author has new findings of detail of effects of photoionizing feedback in isolated clouds and colliding clouds by numerical simulations, and these will contribute to understanding of massive star formation theory in Astrophysics

Therefore, we acknowledge that the author is qualified to be granted a Doctorate of Science from Hokkaido University.