別紙4

# 主　論　文　の　要　旨

論文題目　Numerical Radiation Hydrodynamics of Protostellar Collapse: An Application to the Formation of Brown Dwarfs

重力崩壊と原始星形成過程の数値的輻射流体力学：
褐色矮星形成過程への応用

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## 論　文　内　容　の　要　旨

Our galaxy is continuously forming new stars. The nuclear fusion processes within those stars create elements heavier than hydrogen and helium, many of which are returned to the interstellar medium once the star ends its life as a red giant or a supernova. New generations of stars then form with different levels of heavy elements, and in this way stars drive the evolution of the galaxy, and ultimately the universe as a whole, over cosmological timescales. Therefore, a profound understanding of stars and their formation is essential for the field of astrophysics as a whole.

The formation of stars is a complex process which involves physical scales ranging from the size of whole galaxies to that of interstellar dust particles. The focus of this thesis is the process by which an individual star forms from the gravitational collapse of a cloud of gas, i.e. a molecular cloud core. We are especially interested in the formation of very low-mass objects such as brown dwarfs and sub-brown dwarfs, since this mass regime has so far been underexplored and presents a number of scientific questions and challenges.

In order to investigate this so-called “protostellar collapse”, we first develop a new numerical scheme for solving the radiative transfer equation in a spherically symmetric system. This scheme does not rely on any kind of diffusion approximation and it is accurate for optically thin, thick, and intermediate systems. We then perform various test calculations with this method, including a simplified protostellar collapse simulation.

In the next step, we apply our scheme to the numerical simulation of brown dwarf formation by turbulent compression. In this scenario, brown dwarfs are formed as a result of an external turbulent pressure acting on the molecular cloud core, which would otherwise be stable to gravitational collapse. We investigate the possibility of this mechanism and the necessary conditions for it to occur.

Finally, we expand our method to include a more realistic equation of state that allows us to model the whole collapse process from the initial cloud core to the formation of the protostar. We perform a number of simulations mainly of the brown dwarf mass regime and discuss the results.