

## Science and Technology

### Theoretical Studies on Binary System Protoplanetary Disk and Circumbinary Planetary Disk

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#### Background of Research

Although we cannot see the image of the sun or earth when they were born about 4.5 billion years ago, we still can find newborn stars in the night skies today. Around these young stars, there is a disk made up of gas or dust part of which is going to be planets eventually. For the first time, we directly photographed a disk which is around twin stars (binary stars). The observation of this binary system can give us an important clue that will clarify the formation of binary stars which belong to a majority group in the universe.

#### Achievements of Research

The name of the stars we successfully photographed this time is SR24 in Ophiuchus. In our photo shooting session of the stars, we used a corona graph with adaptive optics in order to hide the binary stars, the main part of SR24. (See photo on the left) Since the disk is reflecting the light from the stars, if the stars are photographed together, the disk can be too dark to be seen. The distance between the two stars is short, and thus high skills are required to hide only the stars.

As seen in the photo taken, the outstanding features discovered are; the lower disk is brighter and more extended and a bridge connecting the two disks is recognized. These features naturally seem to provide evidence that gas is being supplied from outside the two disks to the upper and lower disks. As the star seen below is heavier, it may have stronger gravity and thus gather more gas. The 'bridge' suggests there is a flow of gas between the two gas disks.

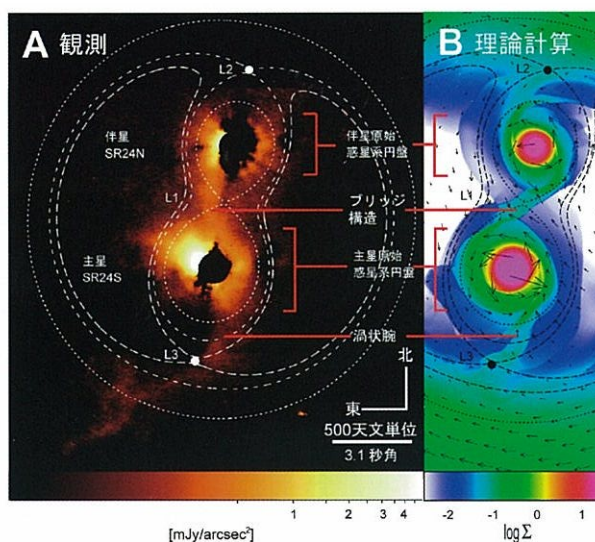
The figure on the right hand side is a simulation result of the gas flow in this binary system, favorably reproducing the image of SR24 photographed by the Subaru Telescope.

The above research is a joint project of the Graduate University for Advanced Studies, National Astronomical Observatory of Japan, Hosei University, and other institutions. The photo we posted herein is the results of recalculation after the photo shooting, but what triggered a development leading to this joint project was some individuals who realized that the observation by the Subaru Telescope and

the simulation from our past researches are very similar.

#### Prospect of Research

The simulation we conducted this time was 2-dimensional calculation based on the approximation premise that the disk is thin, so now we are working on the 3-D structural calculations. We are making efforts to realize a simulative 3-D structure that can be commented as "similar."



Left: Infrared image of SR24 taken by the Subaru Telescope (National Astronomical Observatory of Japan, Graduate University for Advanced Studies). Right: a reproduced numerical simulation (Chiba University)