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## 電波天文学Ⅱ Radio Astronomy Ⅱ

科目コード(Course Number) 20DASb05

物理科学研究科 School of Physical Sciences 天文科学専攻  
Department of Astronomical Science 電波天文学 Radio Astronomy  
学年(Recommended Grade) 1年 2年 3年 4年 5年  
2単位(credit) 後学期 2nd semester  
長谷川 哲夫 (HASEGAWA Tetsuo)

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### 〔授業の概要 Outline〕

Observations in millimeter and submillimeter waves have become a fundamental source of information for astronomical and astrophysical researches of diverse subjects, which range from the star-/planet-forming regions in the Solar neighborhood to nearby galaxies, and to the youngest galaxies at  $z \sim 9$  and beyond. In this course, we review the practical methods to "read" the observed data and digest them in terms of physical processes in the interstellar medium. We start from the basic level for those who have not used (sub-)millimeter data, but also include some advanced ideas introduced to approach specific problems.

### 〔到達目標 Aim〕

For beginners --- Be able to derive physical parameters (such as temperature and density) of an astronomical object from the observed data in millimeter and submillimeter waves. Understand their applicability and limitations. Be encouraged in using archival data for research and in writing observing proposals to ALMA and other millimeter/submillimeter telescopes.

For advanced students --- Be able to think of optimum observations and data analyses according to the scientific needs and observational limitations. Be encouraged to devise a novel and original method of observations and/or data analysis as needed. Be more confident in writing observing proposals to ALMA and other millimeter/submillimeter telescopes.

### 〔成績評価 Grading criteria〕

Problems for reports are given toward the end of the course.

Active participation to the lecture course is an important additional component of evaluation.

### 〔授業計画 Lecture plan〕

1. Introduction --- What is millimeter/submillimeter astronomy? What can we learn from the data?
2. Spectral lines and continuum
3. Radiative transfer basics
4. Cases of Local Thermodynamical Equilibrium (1)
5. Cases of Local Thermodynamical Equilibrium (2)
6. Approaches to non-LTE cases (1)
7. Approaches to non-LTE cases (2)
8. Astrophysical masers
9. Polarization (1)
10. Polarization (2)
11. 3-dimensional astronomy
12. A bit of astrochemistry (1)
13. A bit of astrochemistry (2)
14. Let's work on actual data (1)
15. Let's work on actual data (2)

### 〔実施場所 Location〕

Mitaka campus of the National Astronomical Observatory of Japan.

### 〔使用言語 Language〕

Spoken --- English, Written --- English

(If all attending students understand Japanese, I may speak in Japanese.)

### 〔教科書・参考図書 Textbooks and references〕

Provided lecture materials will include references.

### 〔関連URL Related URL〕

URL:

〔上記URLの説明 Explanatory Note on above URL〕

### 〔備考・キーワード Others/Keyword〕

radio astronomy, millimeter, submillimeter, interstellar matter, spectroscopy