一、課程說明 (Course Description)

This course review our current understanding of the Universe with emphasis on the observational evidence and theoretical background of individual subjects. We will explore topics in the geometry of the Universe, inflation, Big Bang, dark matter, dark energy and gravitational lensing. Our goal is to provide students with a summary of our current understanding of the Universe, and what topics remain to be explored. The material is presented without complex mathematics as much as possible. Previous knowledge of general relativity is not required. At the beginning of each class, a student is assigned to review the material from the previous week. This course will be offered in English.

One of the notorious difficulties in astronomy is in understanding 3D structures of the Universe based on 2D images from telescopes. In this semester, I will use 3D goggles and 3D printers to let students experience 3D structures of the Universe. It will be a fun moment for students

1. to walk through the large scale structures of the Universe,
2. to peek inside of the supernova explosion in 3D.
3. to feel the size of the solar system in 3D
4. to experience the speed of the light, and general relativistic effects in 3D. What happens if you are traveling at the speed of light, and look back?

At the end of the semester, students are also required to use 3D goggles or a 3D printer to create a 3D model of an astronomical object, and explain astrophysics behind. Students will have a better understanding of the Universe while creating 3D models.

二、課程內容 (Course Content)

: *Introduction: Olbers' paradox, FRW Metric, Cosmological Parameters, Flatness problem.
: *Cosmological distance measures, edge and fate of the Universe
: Cosmic microwave background I: Discovery, big bang nucleosynthesis.
: Cosmic microwave background II: Inflation.
: *Cosmic microwave background III: Acoustic peaks, Sachs-Wolfe effect, reionization.
: Cosmic microwave background IV: Polarization, and primordial gravitational wave
: Dark energy I: Type Ia supernova, cosmic distance ladder
: Dark energy II: BAO, SZ effect. f_gas, cluster counts, redshift space distortion
: *Three evidences of dark matter
: *Gravitational lensing I: Einstein radius, surface brightness conservation, time delay
: *Gravitational lensing II: odd number theorem, inverse magnification theorem, caustics
: *Gravitational lensing III: Cosmic shear and its cosmological application

*Lectures with 3D goggles/printers.

三、參考書籍 (References)

"Observational Cosmology" by Stephen Serjeant (Cambridge University Press, 2010)

"Accelerating Universe" by Dragan Huterer (http://arxiv.org/pdf/1010.1162v3.pdf)

"Dark Energy and Accelerating Universe" by Frieman et al.
(http://arxiv.org/pdf/0803.0982v1.pdf)

"Distance measures in Cosmology" by David Hogg (http://arxiv.org/abs/astroph/9905116)

“Principles of Physical Cosmology” by P.J.E. Peebles (Princeton Uni- versity Press, 1993).

”Modern Cosmology” by S. Dodelson (Academic Press, 2003).

"An Introduction to Modern Cosmology 2nd ed." by Liddle. (Wiley)

”Cosmological Physics” by J.A. Peacock (Cambridge University Press, 1999).

”An Introduction to Cosmology” by J. Narlikar (Cambridge University Press, 2002).

”Spacetime and Geometry: An Introduction to General Relativity” by Sean M. Carroll (Addison Wesley,
2004).

四、教學方式(Teaching Method)
Lectures

五、成績考核(Evaluation)
Mid-term and final presentations. For the final presentations, students are required to use 3D goggles or a 3D printer to produce a model of an astronomical object of their choice, and explain the astrophysics behind it.