课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	MAE5026 海外专家讲学 Lectures from Oversea Experts
2.	**课程性质** **Compulsory/Elective**	选修、Elective
3.	**课程学分/学时** **Course Credit/Hours**	1 学分 / 16 学时
4.	**授课语言** **Teaching Language**	英语
5.	**授课教师** **Instructor(s)**	Luca Biferale
6.	**先修要求** **Pre-requisites**	无
7.	**教学目标** **Course Objectives**	
	The course is meant to introduce students to open problems to understand basic properties of turbulent flows for both Eulerian and Lagrangian descriptions, with focus on large- and small-scale statistics, deviations from Gaussian behavior, direct and inverse cascades. Finally, we shortly present a couple of applications to Helical and Rotating flows in finite or infinite volumes. 本课程旨在向学生介绍欧拉和拉格朗日描述的湍流中的开放性问题，重点是不同尺度的统计特性，直接和反向级联。最后，我们简要介绍有限或无限体积中的螺旋和旋转流动的几个应用。	
8.	**教学方法** **Teaching Methods**	
	板书+PPT	
9.	**教学内容** **Course Contents**	
	Section 1	Introduction to statistical description of Turbulent flows: real space, Fourier space and scale-filtered representation.
	Section 2	Introduction to statistical description of Turbulent flows: ergodicity, definitions of spectra, flux and high order statistics (Flatness, Skewness)
	Section 3	Multi-scale statistics: non-Gaussian statistics, intermittency, sub-grid energy flux, multifractal phenomenology (Eulerian)
	Section 4	Lagrangian turbulence: tracers, inertial particles, self-propelling particles. Preferential concentration and temporal statistical properties.
	Section 5	Homogeneous and Isotropic flows: state of the art in 3d. Direct energy cascade. K41 Theory and corrections to it.
	Section 6	Homogeneous and Isotropic flows: state of the art in 2d. Inverse energy cascade and direct enstrophy cascade. Kraichnan-Batchelor theory.
	Section 7	Helical properties in 3d flows. Eulerian and Lagrangian (helicoids).
	Section 8	Effects of Rotation: transition from direct to split energy cascades.
10.	**课程考核** **Course Assessment**	

	请再此注明：①考查/考试；②分数构成。 考察；出勤+报告
11.	**教材及其它参考资料** **Textbook and Supplementary Readings**
	[1] U. Frisch. Turbulence (Cambridge University Press, 1995) [2] S.B. Pope. Turbulent Flows (Cambridge University Press, 2000) [3] A. Alexakis and L. Biferale. Cascades and transitions in turbulent flows. Phys. Rep. 2018 https://doi.org/10.1016/j.physrep.2018.08.001 arXiv:1808.06186 [4] F. Toschi and E. Bodenschatz. Lagrangian Properties of Particles in Turbulence. Annu. Rev. Fluid Mech. 41, 375 (2009)