

2014 Autumn Semester, course for graduate student

# Lecture notes: Physics of Laser-Plasma Interactions

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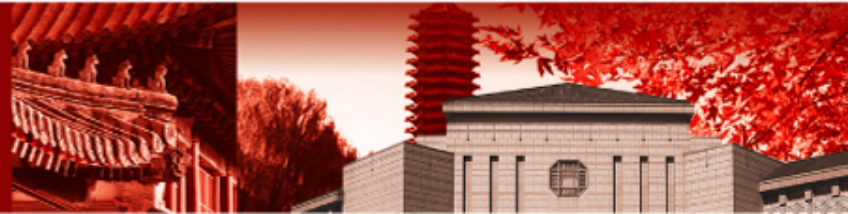
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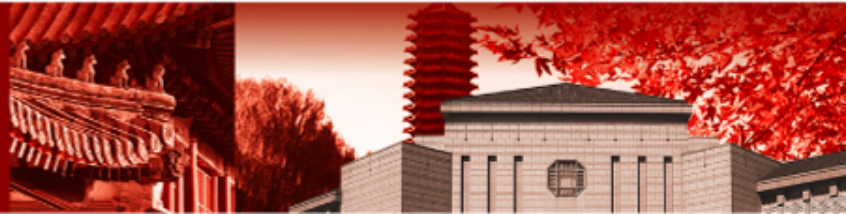


# Introduction to this course

- Why should we learn laser-plasma interaction (LPI)?
- What shall we learn?
- What books should we referee?
- What should I do if I have questions?
- Examinations.

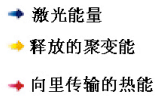


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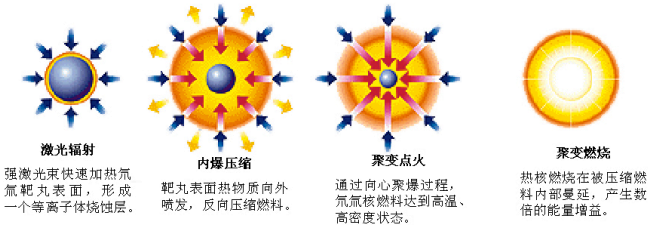


# Why should we learn LPI?

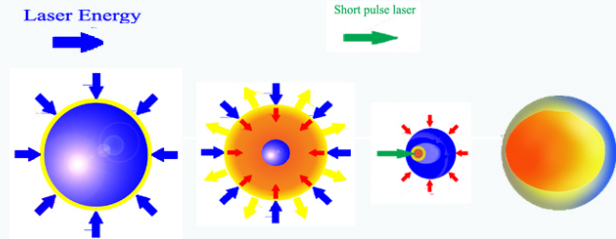
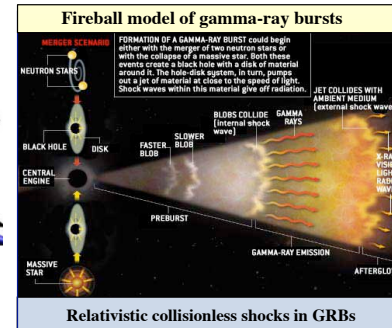
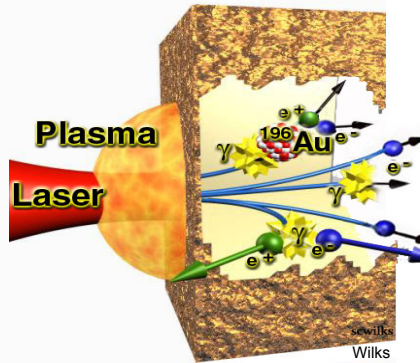
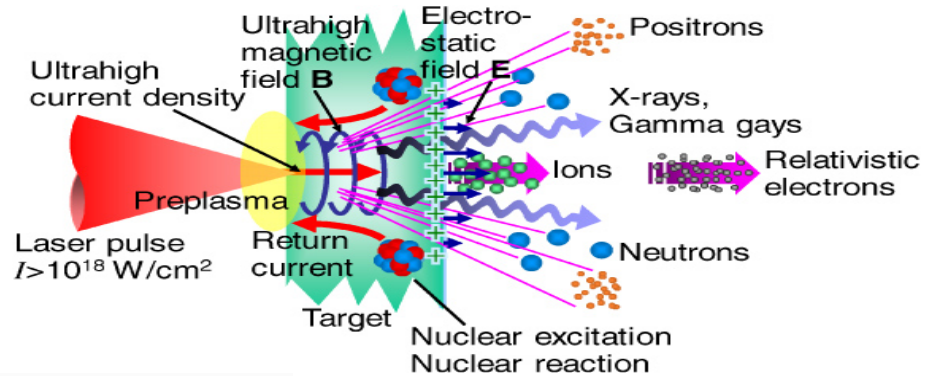
# 1. LPI has broad applications from Inertial Confinement Fusion (ICF) to laboratory Astrophysics



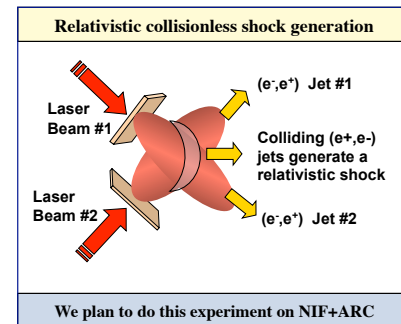
## 惯性约束聚变(ICF)的四个阶段



# 10<sup>14</sup>-10<sup>15</sup>W/cm<sup>2</sup> LPI


$$>10^{18} \text{W/cm}^2$$


[Gehrels, Piro, Leonard, Sci. Am., 86-90 (Dec, 2002)]

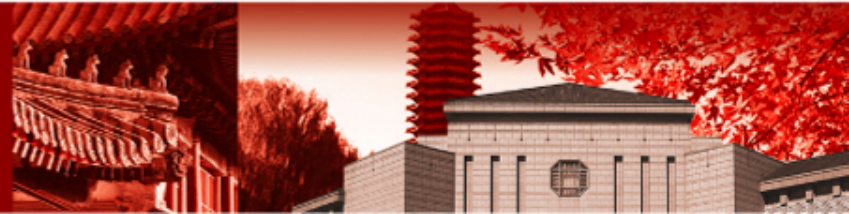


[Courtesy of Hui Chen (2010)]

**Energy science, Biology Science, Material Science, Life science, Nuclear science**

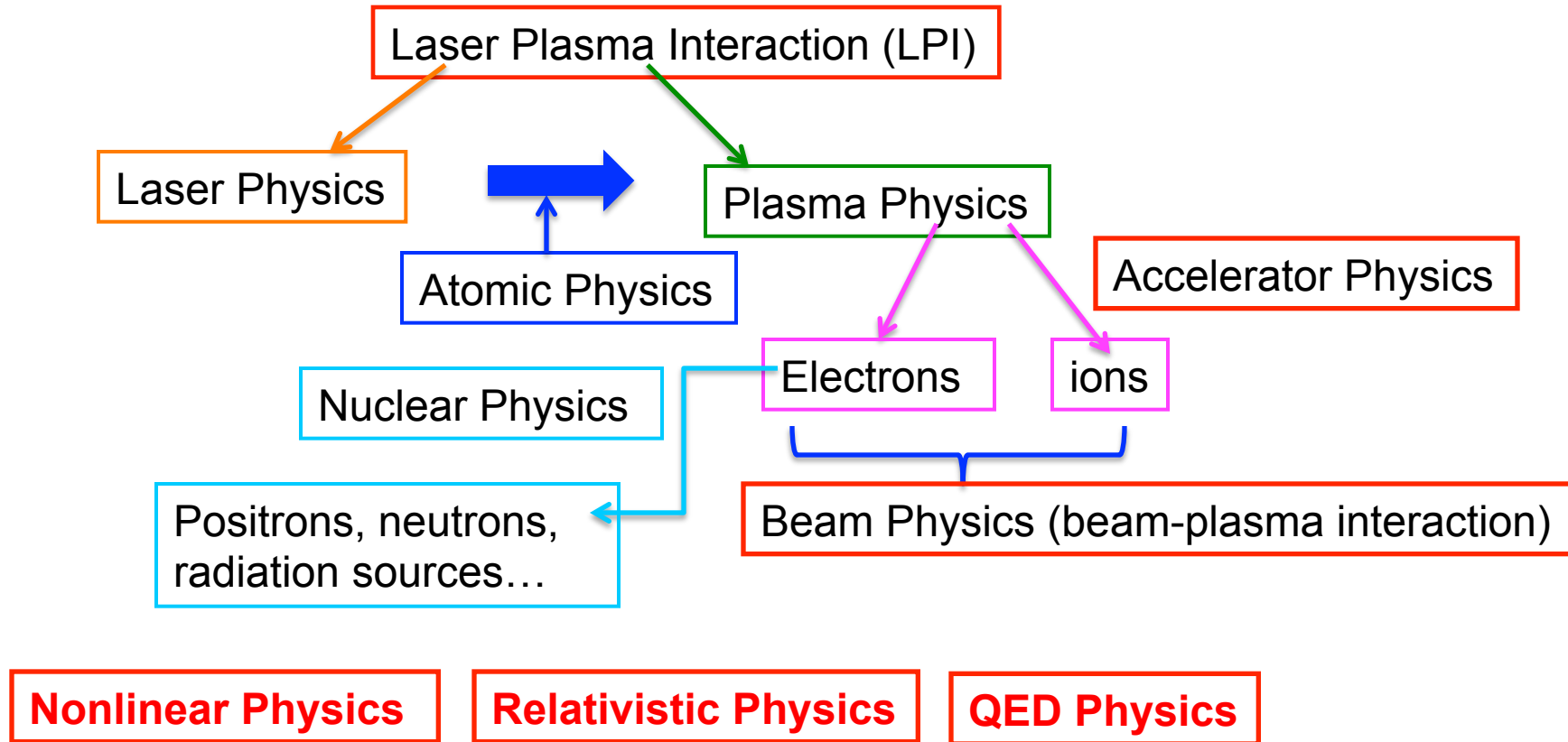


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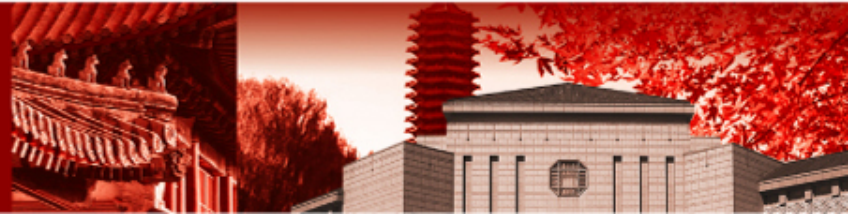


# Why should we learn LPI?

2. LPI is a field of great physical interest due to richness of physics.

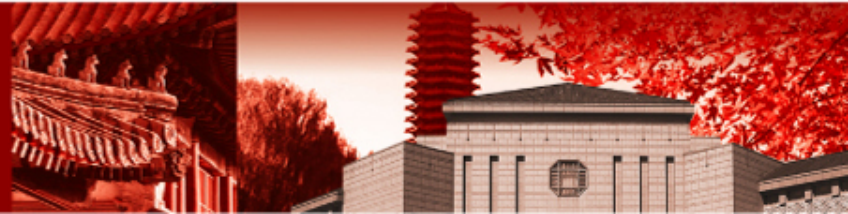


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# What shall we learn?

- **Basic concepts and theories of LPI**  
characteristic of scales, physical variables, basic equations, theoretical methods
- **Long-pulse (unrelativistic) LPI (nanosecond,  $10^{15}$ - $10^{17}$ W/cm<sup>2</sup>, underdense)**  
laser absorption mechanism, parametric instabilities (SRS, SBS), focusing, filaments
- **Short-pulse relativistic LPI (fs - ps,  $>10^{18}$ W/cm<sup>2</sup>, near-critical, solid)**
  - ✧ Interaction with single atoms, single electrons, single ions
  - ✧ Interaction with underdense plasma (wakefield electron acceleration)
  - ✧ Interaction with solids
  - ✧ Laser-driven ion acceleration
  - ✧ Radiation source – HHG, XUV, X-ray, and production
- **Introduction of numerical methods for LPI**  
Particle-in-cell, Vlasov, Fokker-Planck, Rad-Hydrodynamic



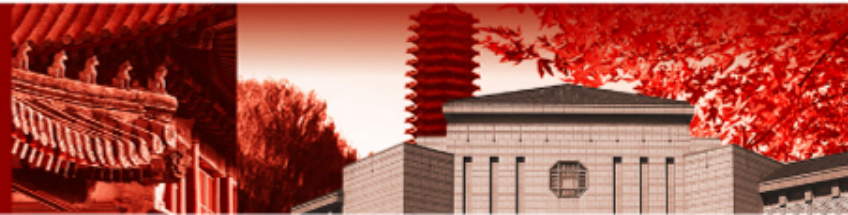


# What books should we referee?

- 张家泰, 激光等离子体相互作用物理与模拟, 河南科学技术出版社, 1999
- P. Gibbon, Short Pulse Laser Interaction with Matter, 2005
- Andrea Macchi, A Superintense Laser-Plasma Interaction Theory Premier
- C. K. Birdsall, Plasma Physics via computer simulation, McGraw-Hill Book, 1985
- The Physics of Laser Plasma Interactions William L. Kruer, LLNL
- P. Mulser and D. Bauer, High Power Laser-Matter Interaction, 2010.
- 常铁强等, 激光等离子体相互作用与激光聚变, 湖南科技出版社, 1990
- 邵福球编著, 等离子体粒子模拟, 科学出版社, 2002
- S. Atzeni and J. Meyer-ter-Vehn, The Physics of Inertial Fusion, 2009
- D. A. Jaroszynski and R.A. Bingham, Laser- Plasma Interactions, 2008
- 1000s of publications on Phys. Rev. Lett. Phys. Plasmas ....



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# What should I do if I have questions?

- **Come to my office :**

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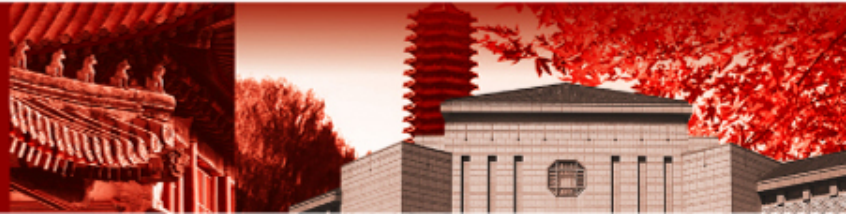
- **Email me:**

bqiao@pku.edu.cn

- **Consulting books, papers, google search...**
- **Lecture notes will be uploaded to pan.baidu.com**



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# Examinations ?

- **Schedule:**

3 courses (1 time) /week, total 16 weeks (48hs).

From Sep. 17 2014, January. 14 2015.

- **Credits and evaluation:**

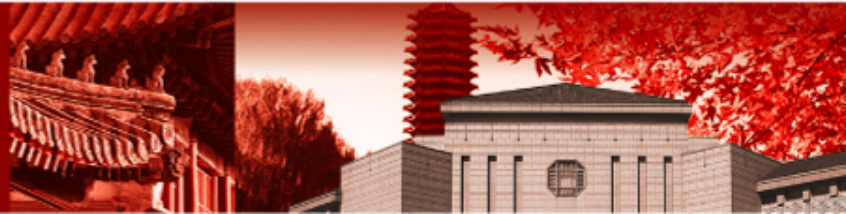
Attendance 10% Homework 30%

Mid-term examination 30%

Final examination 30%



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# 谢谢!



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