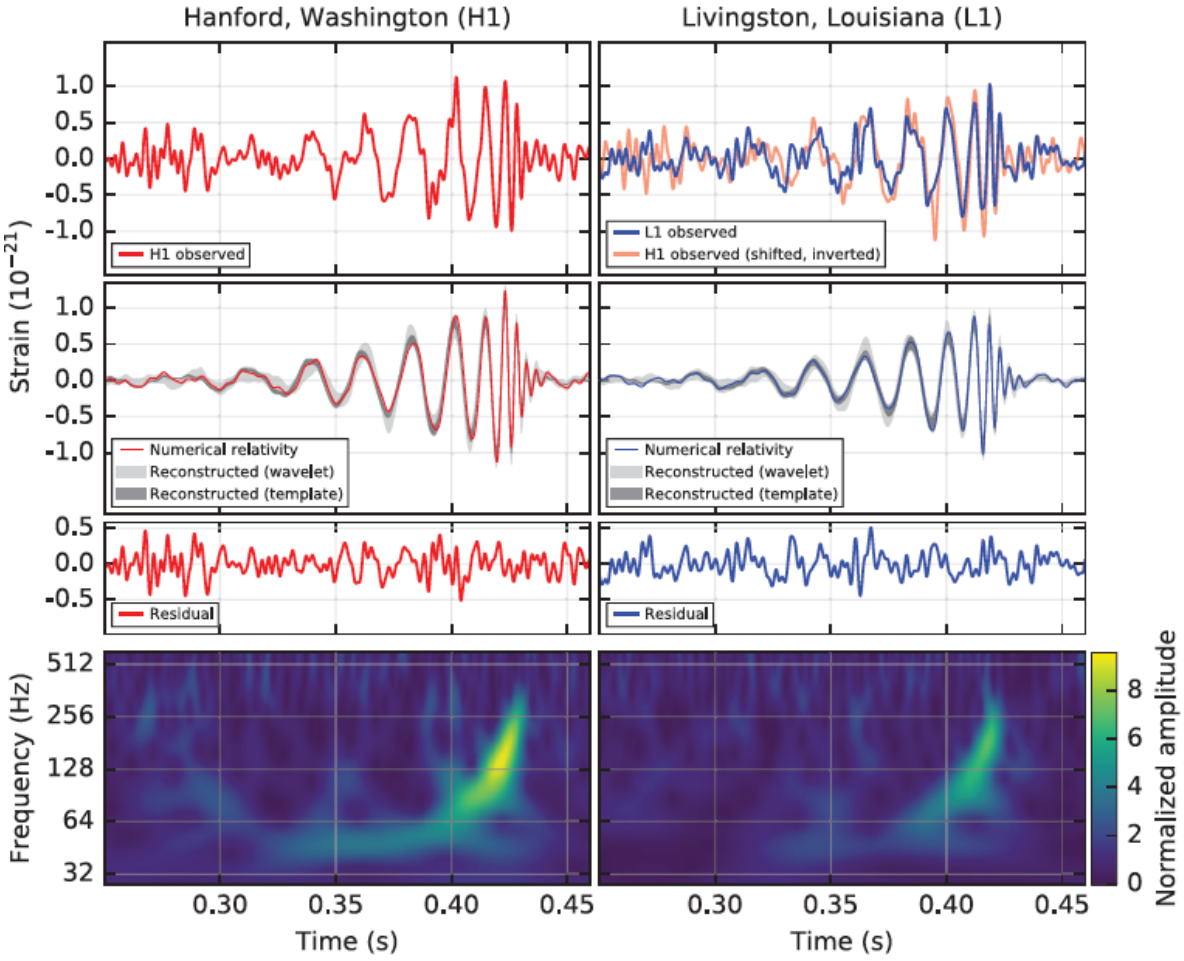

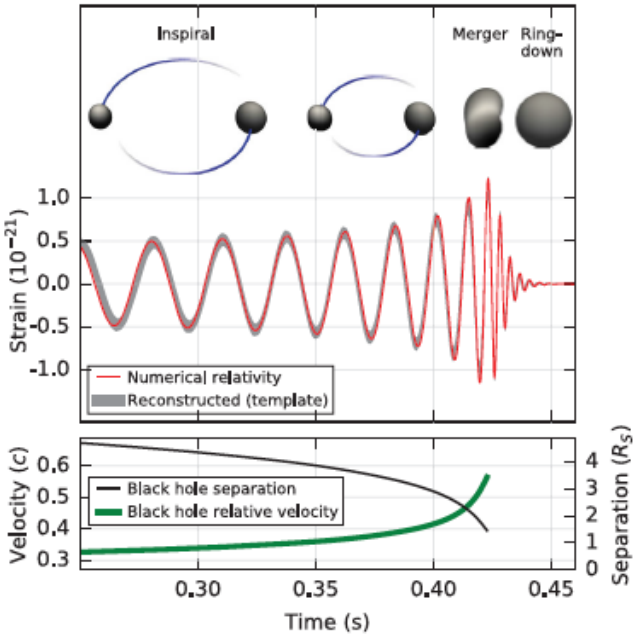

Abbott et al. 2016, PRL, 116, 061102　　人类已经开始用引力波“聆听”宇宙了！

致密星

仝号

2016年3月

前言

- 分享对致密星和高能天体物理的理解
- ppt+板书的方式
- 考试采用文献阅读报告的形式
- 2016-2020每年讲授一次

目录

参考书

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2. Longair M. S., 2011, High energy astrophysics
3. 徐仁新，2006，天体物理导论
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1. 狭义相对论

- Rosswog & Bruggen, 2011, Introduction to high energy astrophysics, Chapter 1

1.1引言

1.2 Lorentz 变换

1.3 狭义相对论效应

1.4四矢量

1.5狭义相对论的电动力学

1.6所有的经典物理

1.1引言

- 动力学理论：
  1. 描述系统的物理量
  2. 物理量随时间的演化
- 量子力学，牛顿力学，狭义相对论

Rosswog & Bruggen 2011

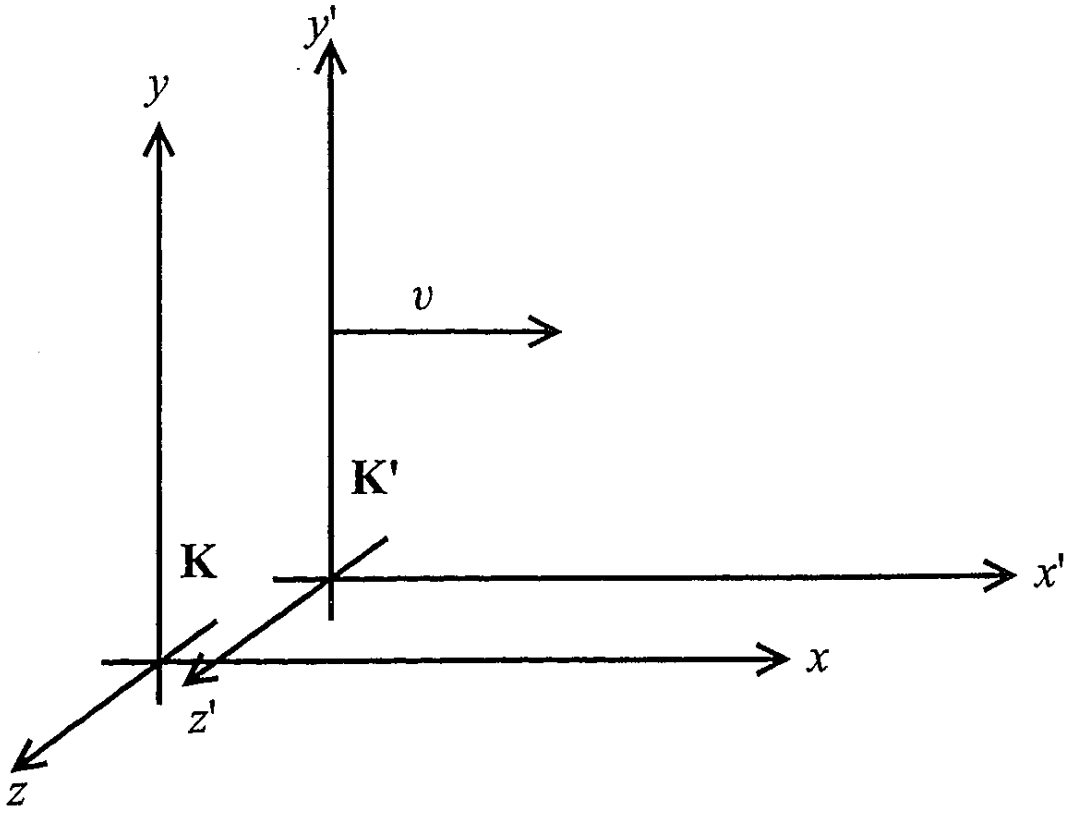

Figure 1.1 Coordinate systems used for the Lorentz transformations: the x-axes are aligned, and the relative velocity between the two frames is v.

1.2 Lorentz变换

- Lorentz 因子: $\gamma = \dfrac{1}{\sqrt{1 - v^2 / c^2}}$
- Lorentz 变换：

$$\begin{cases} t' = \gamma(t - \dfrac{vx}{c^2}) \\ x' = \gamma(x - vt) \\ y' = y \\ z' = z \end{cases}$$

1.3 狭义相对论效应

- Lorentz变换是关于时空事件的变换，时间，长度，速度等物理量可由Lorentz变换推导得出

1.3.1 长度收缩

1.3.2 时间膨胀

1.3.3 相对论集束效应(beaming)

1.3.4 Doppler 效应和视超光速(superluminal motion)

Rosswog & Bruggen 2011

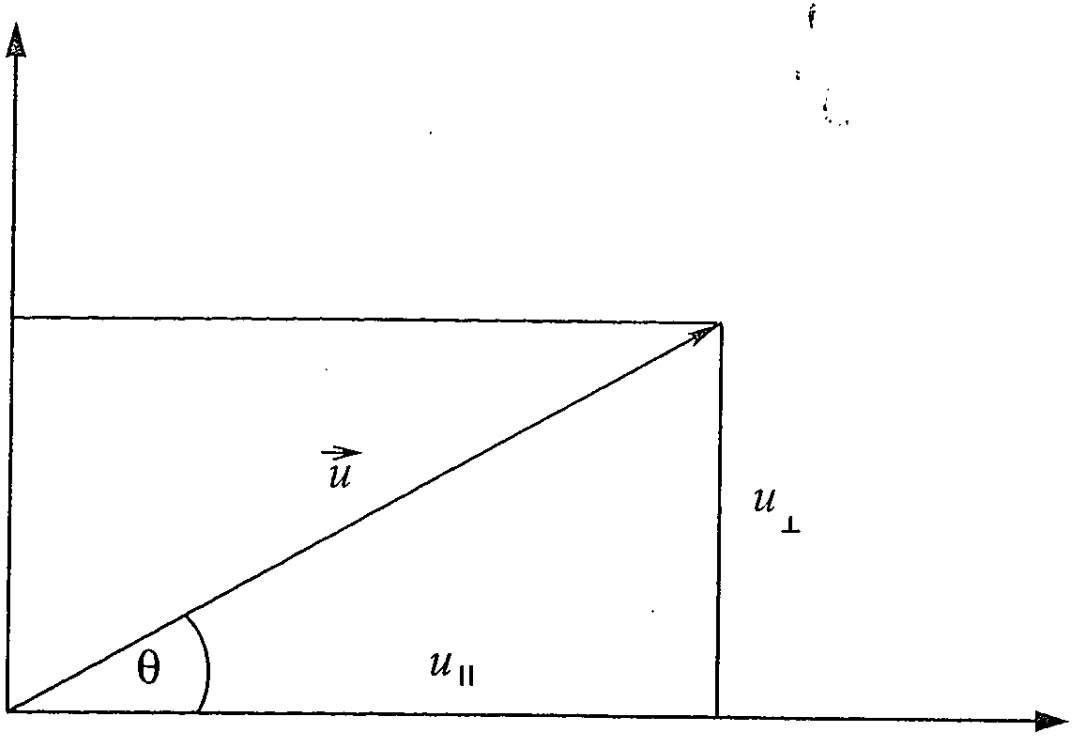

Figure 1.2 For the special relativistic transformation of velocities: splitting the velocity $\vec{u}$ into a component parallel ($u_{||}$) and perpendicular ($u_\perp$) to the velocity between the two frames, v.

Rosswog & Bruggen 2011

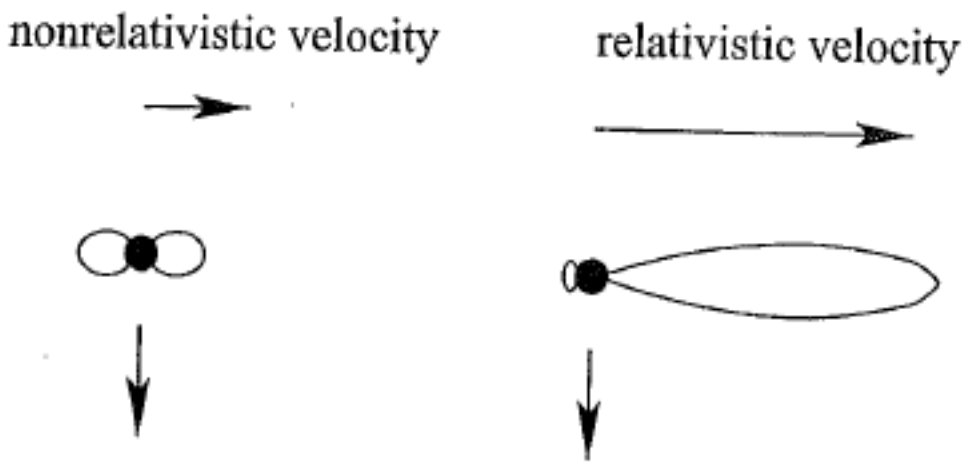

Figure 1.4 Change of a dipole pattern (acceleration perpendicular to the indicated velocity) due to relativistic beaming (left: nonrelativistic, right: relativistic velocity).

Rosswog & Bruggen 2011

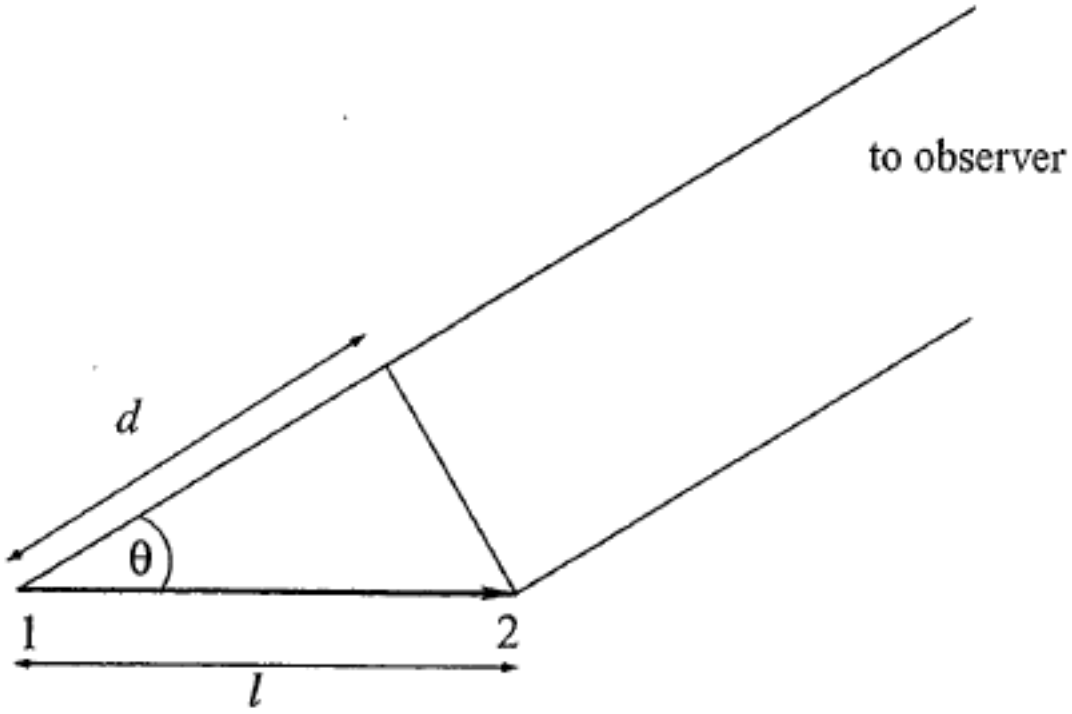

Figure 1.5 A rapidly moving, periodically emitting source travels during one period from point 1 to 2.

1.4 四矢量

- 三维空间中的转动
- 四维时空中的转动

Feynman 物理学讲义第1卷 第11章 矢量

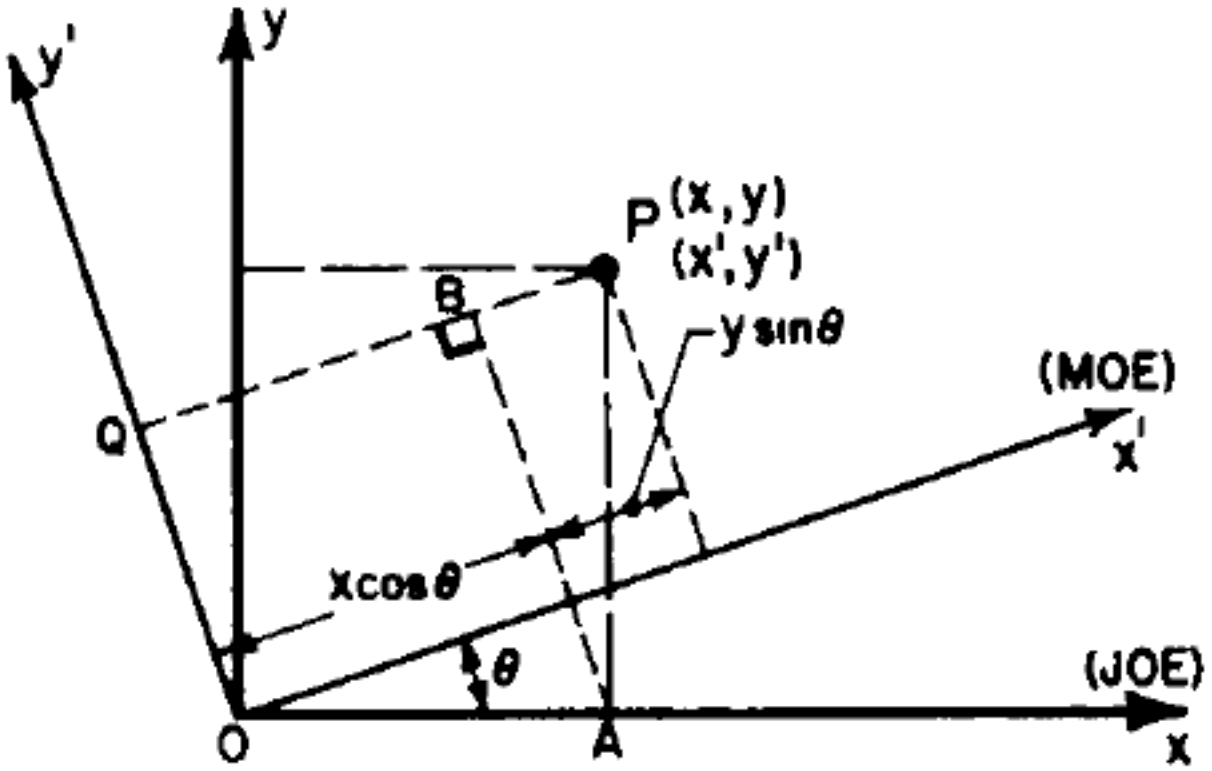

Fig. 11–2. Two coordinate systems having different angular orientations.

1.5 狭义相对论的电动力学

- 电动力学自然满足Lorentz变换

1.6所有的经典物理
(Feynman物理学讲义第2卷 第18章Maxwell方程组)

Table 18-1 Classical Physics

Maxwell's equations

I. $\nabla \cdot \boldsymbol{E} = \frac{\rho}{\epsilon_0}$ (Flux of $\boldsymbol{E}$ through a closed surface) = (Charge inside)/ϵ_0

II. $\nabla \times \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t}$ (Line integral of $\boldsymbol{E}$ around a loop) = $-\frac{d}{dt}$ (Flux of $\boldsymbol{B}$ through the loop)

III. $\nabla \cdot \boldsymbol{B} = 0$ (Flux of $\boldsymbol{B}$ through a closed surface) = 0

IV. $c^2 \nabla \times \boldsymbol{B} = \frac{\boldsymbol{j}}{\epsilon_0} + \frac{\partial \boldsymbol{E}}{\partial t}$ c^2(Integral of $\boldsymbol{B}$ around a loop) = (Current through the loop)/ϵ_0 + $\frac{\partial}{\partial t}$ (Flux of $\boldsymbol{E}$ through the loop)

[**Conservation of charge**

$\nabla \cdot \boldsymbol{j} = -\frac{\partial \rho}{\partial t}$ (Flux of current through a closed surface) = $-\frac{\partial}{\partial t}$ (Charge inside)]

Force law

$\boldsymbol{F} = q(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B})$

Law of motion

$\frac{d}{dt}(\boldsymbol{p}) = \boldsymbol{F}$, where $\boldsymbol{p} = \frac{m\boldsymbol{v}}{\sqrt{1 - v^2/c^2}}$ (Newton's law, with Einstein's modification)

Gravitation

$\boldsymbol{F} = -G\frac{m_1 m_2}{r^2}\boldsymbol{e}_r$

思考题

1. 如何有光速不变导出Lorentz变换(力学)?
2. 用学到的知识考虑Compton 散射(Rosswog & Bruggen 1.4.6 / 原子物理等)。