

Lecture 1

Brief history of the

Universe (A)

Gong-Bo Zhao
NAOC

宇

宙

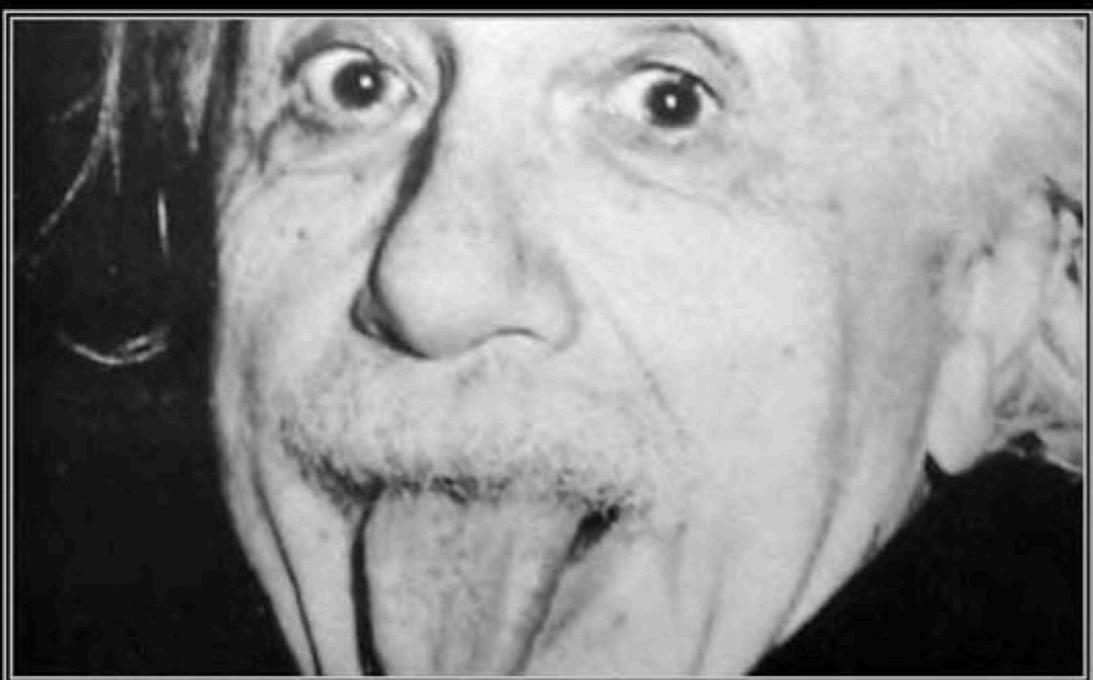
四方上下谓之宇，
往古来今谓之宙。

刘安《淮南子·齐俗》

子

申





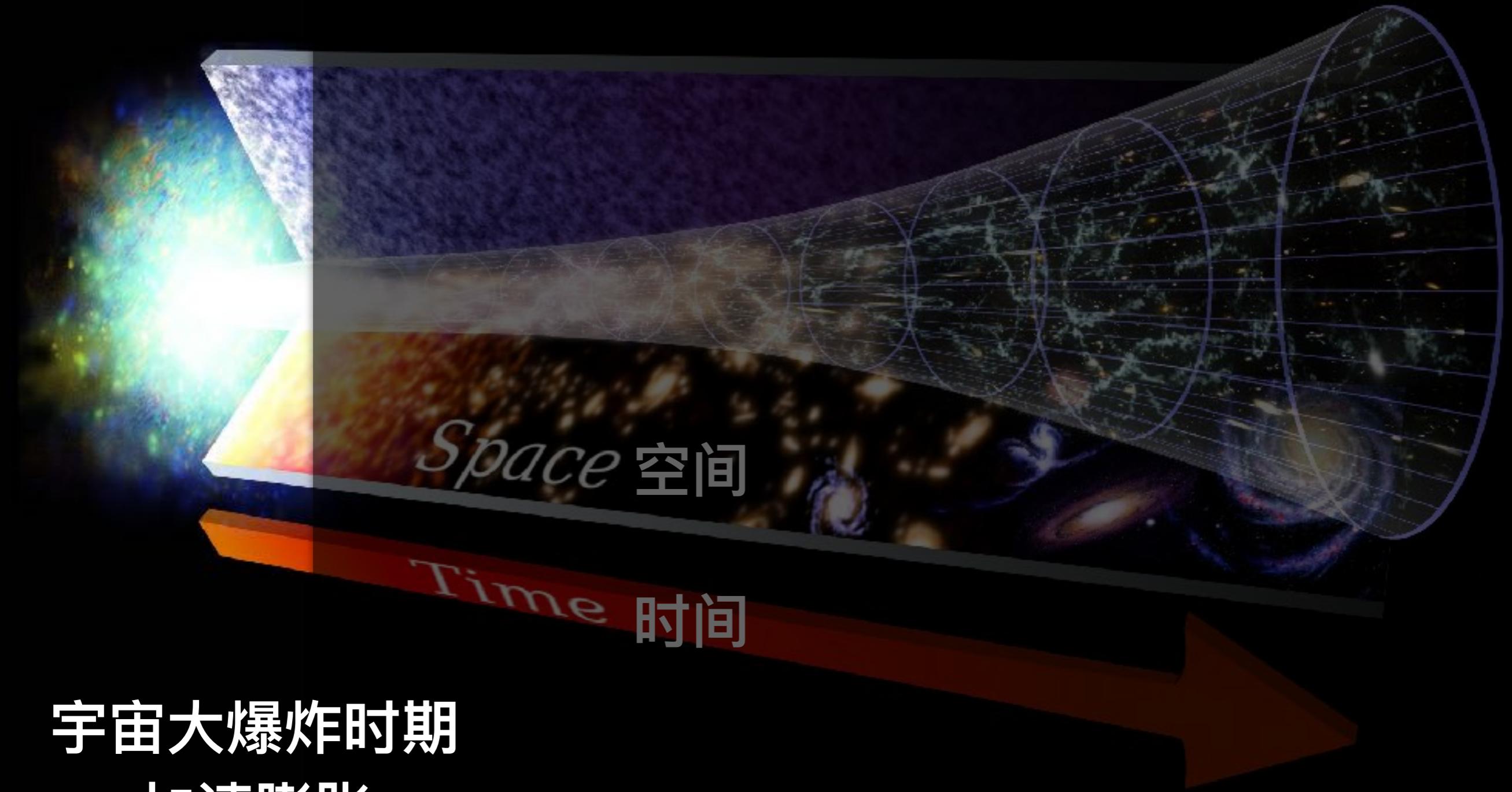
Super Relativity?!



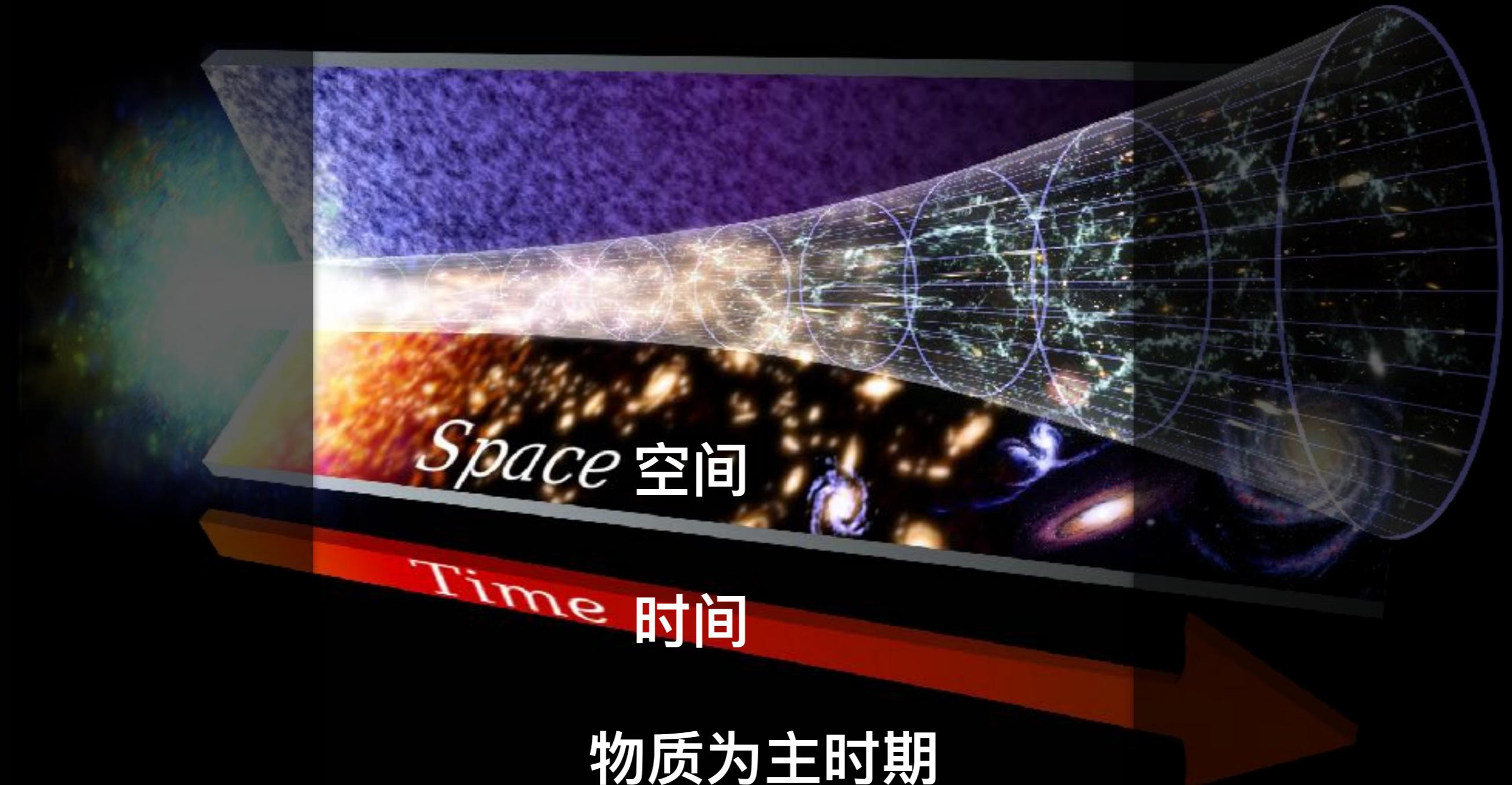
我们的宇宙多少岁？



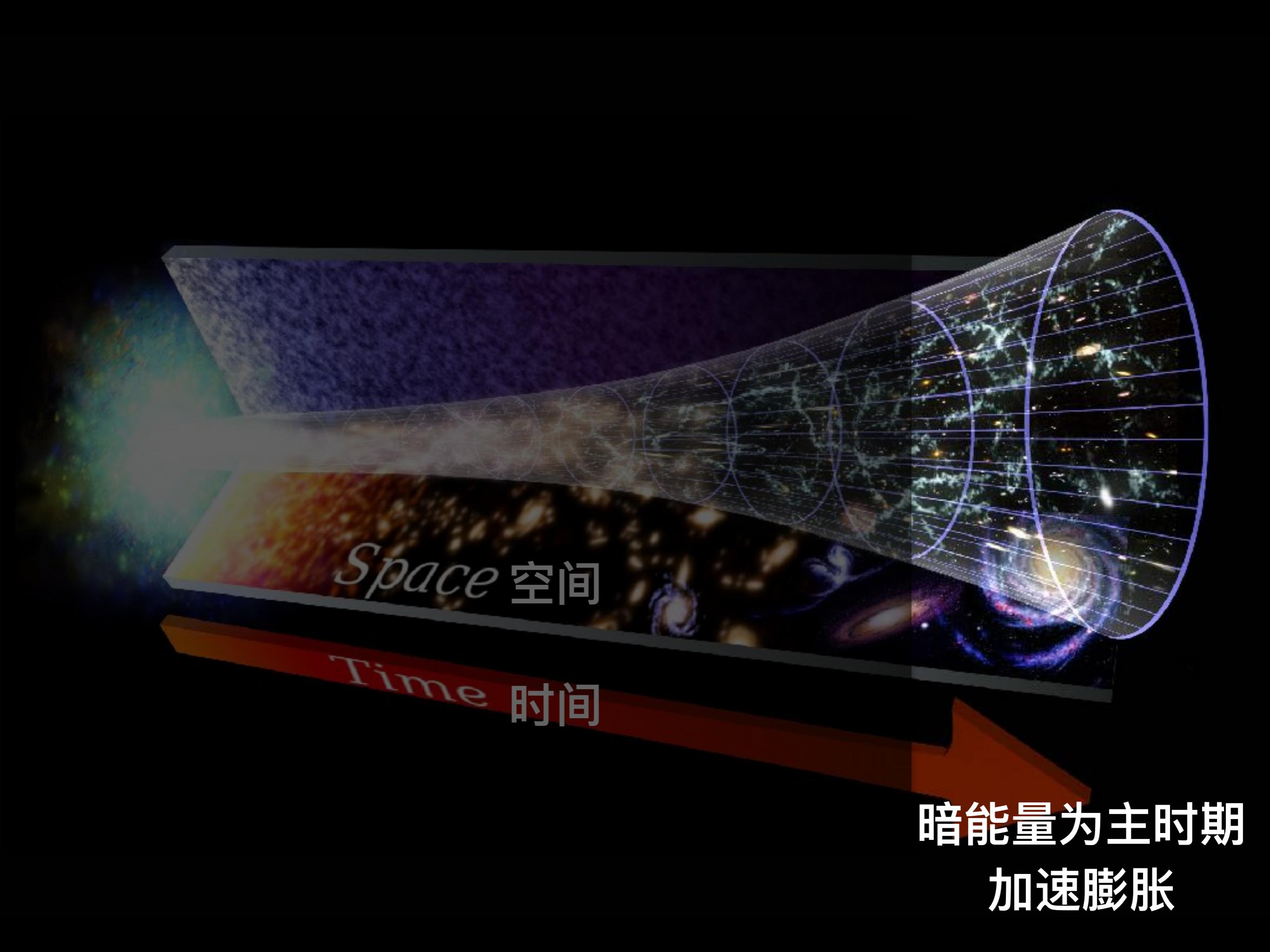
138亿年



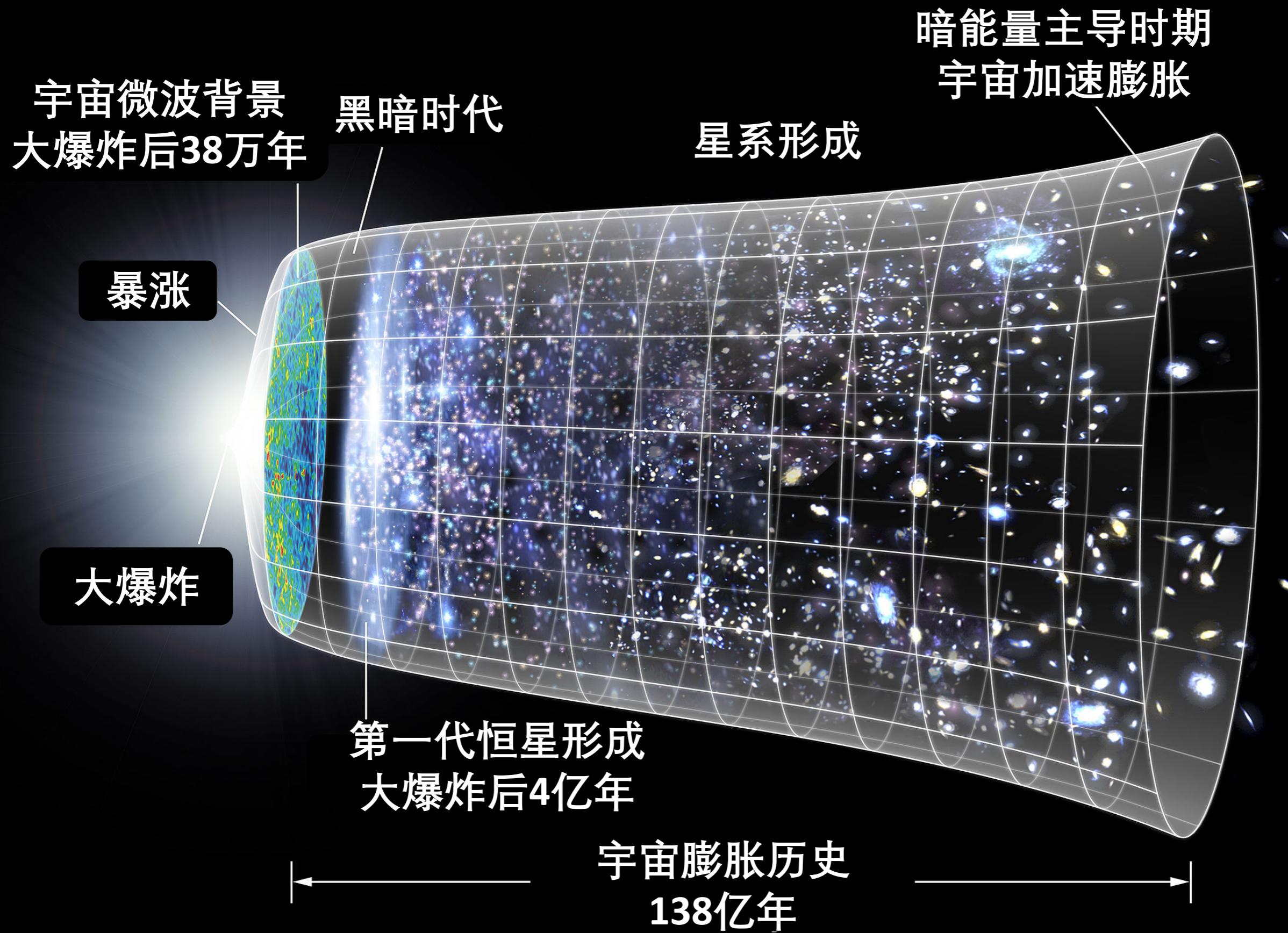
宇宙大爆炸时期
加速膨胀

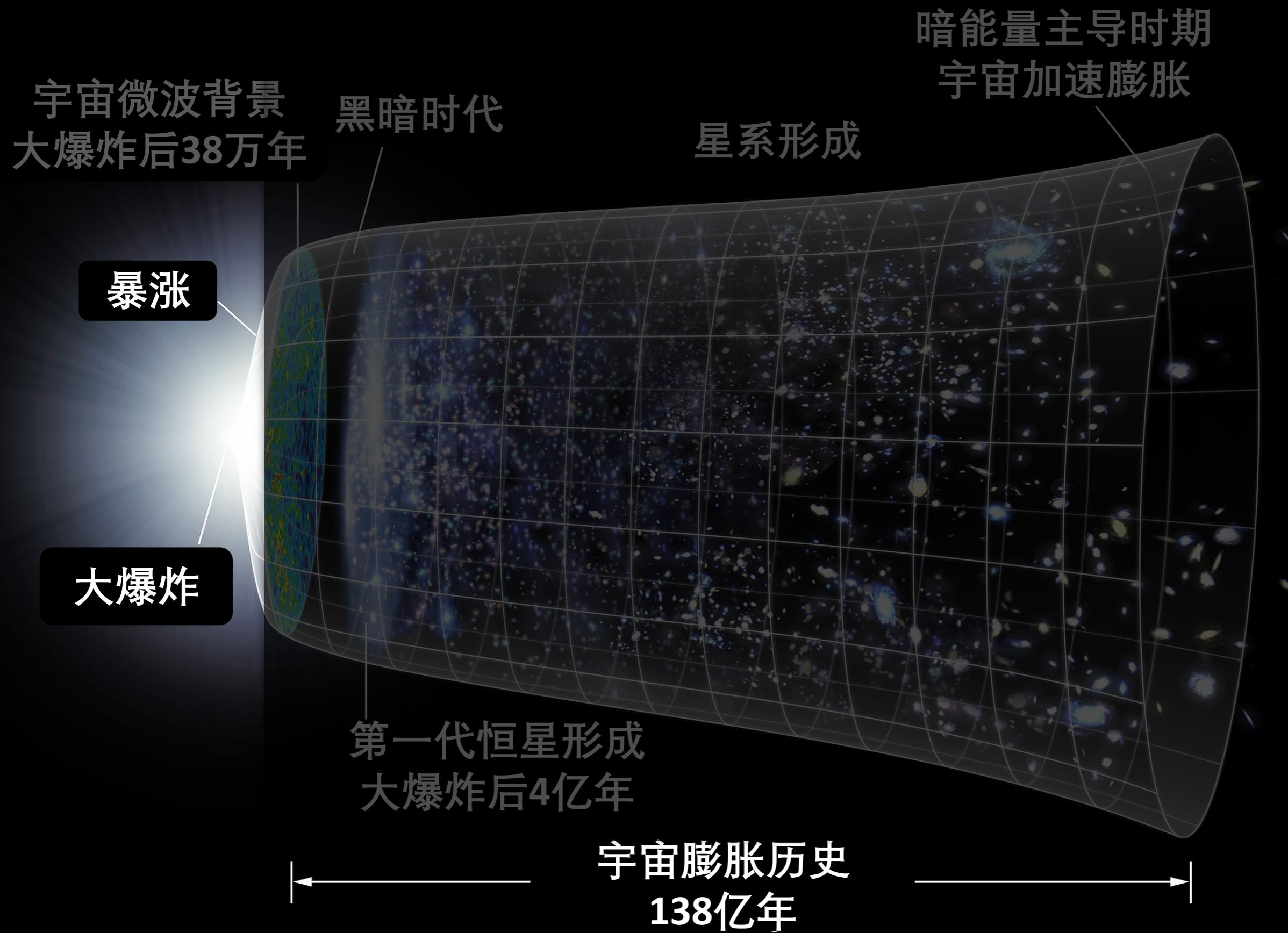


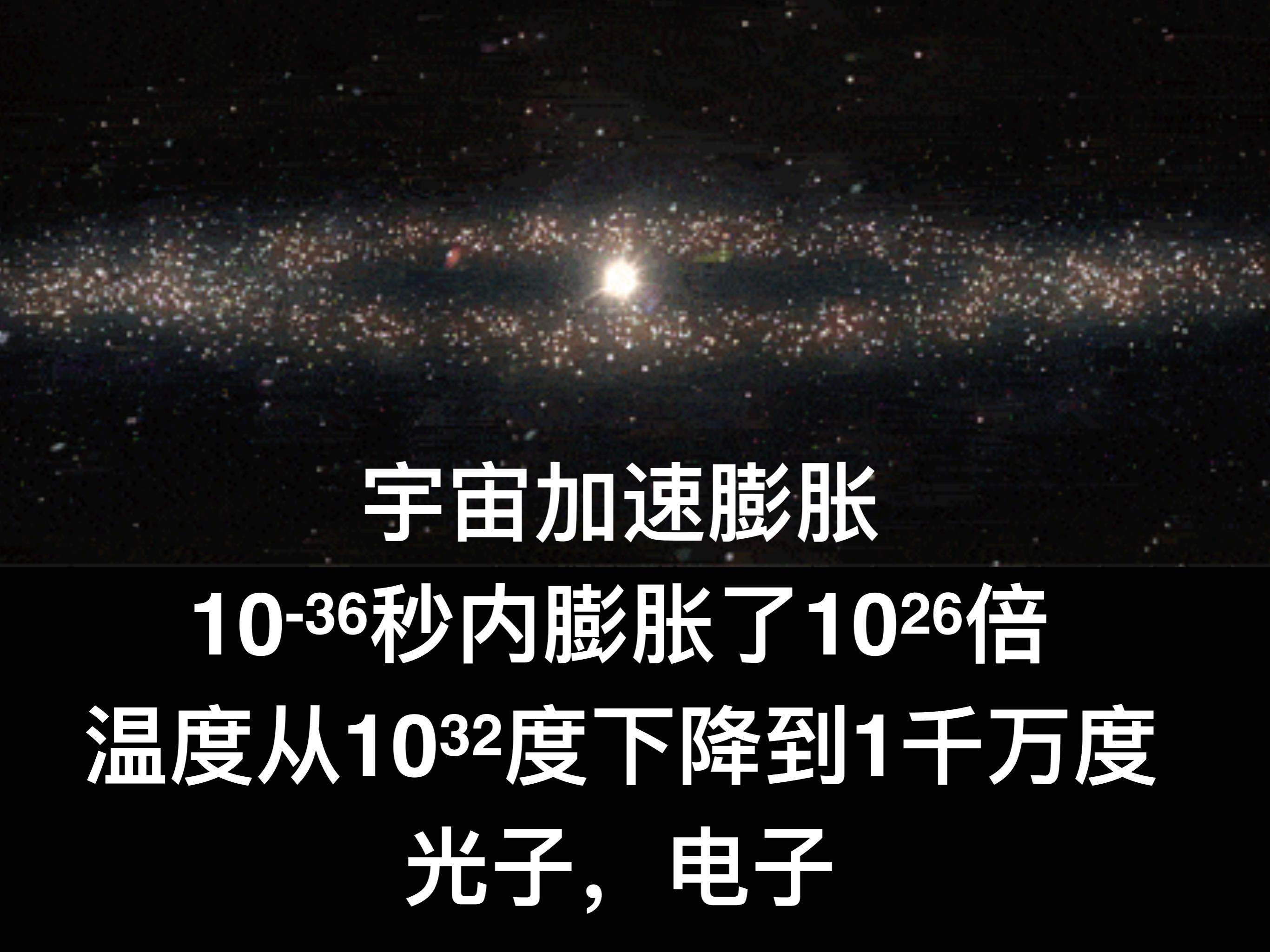
物质为主时期
减速膨胀



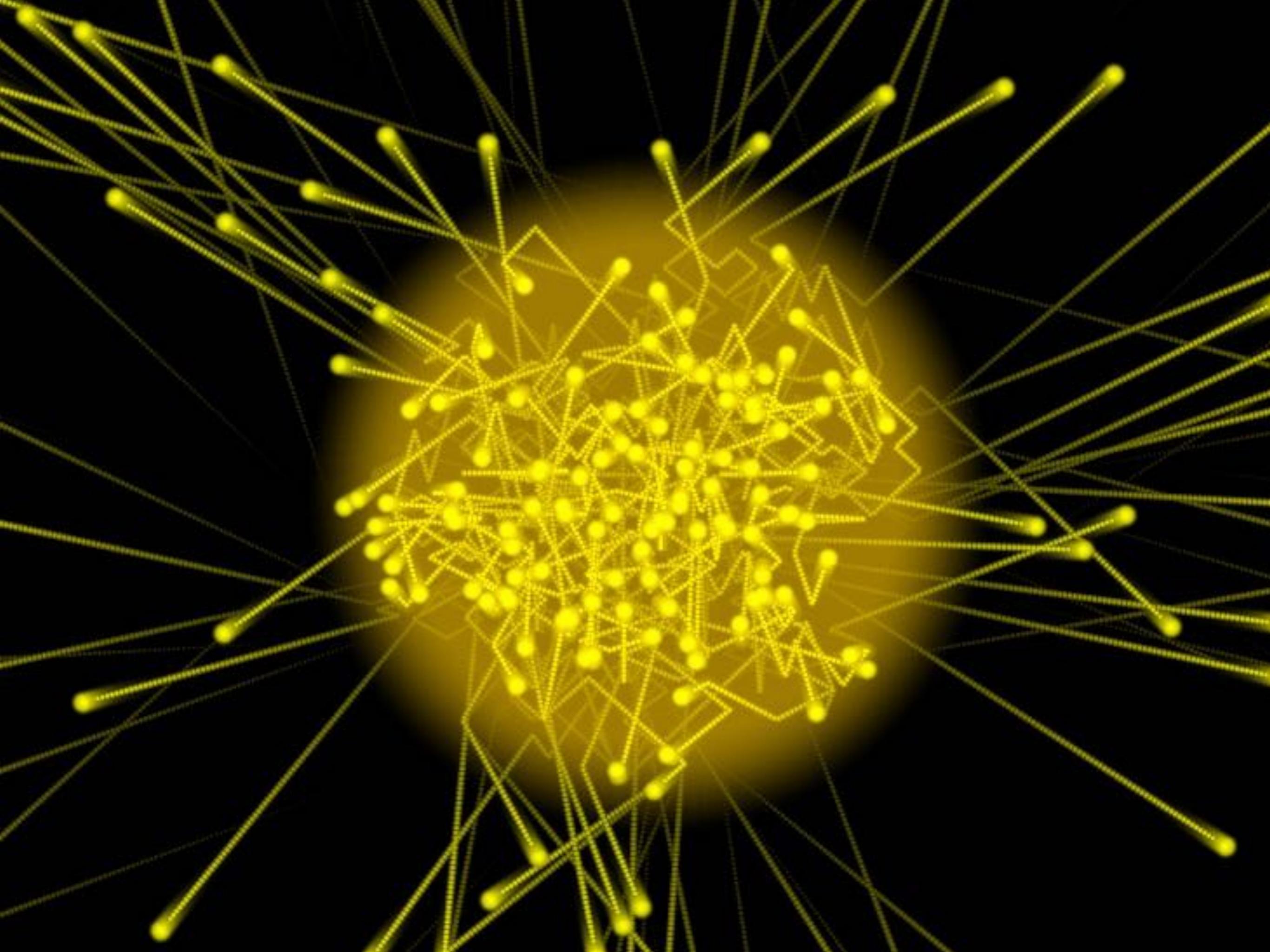
暗能量为主时期
加速膨胀

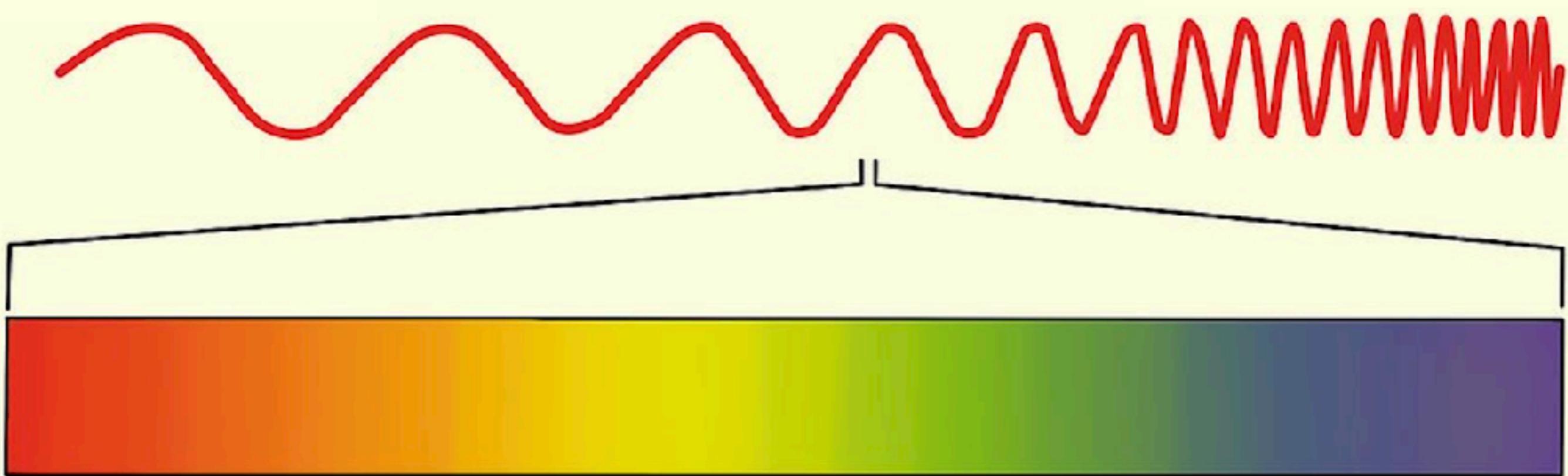


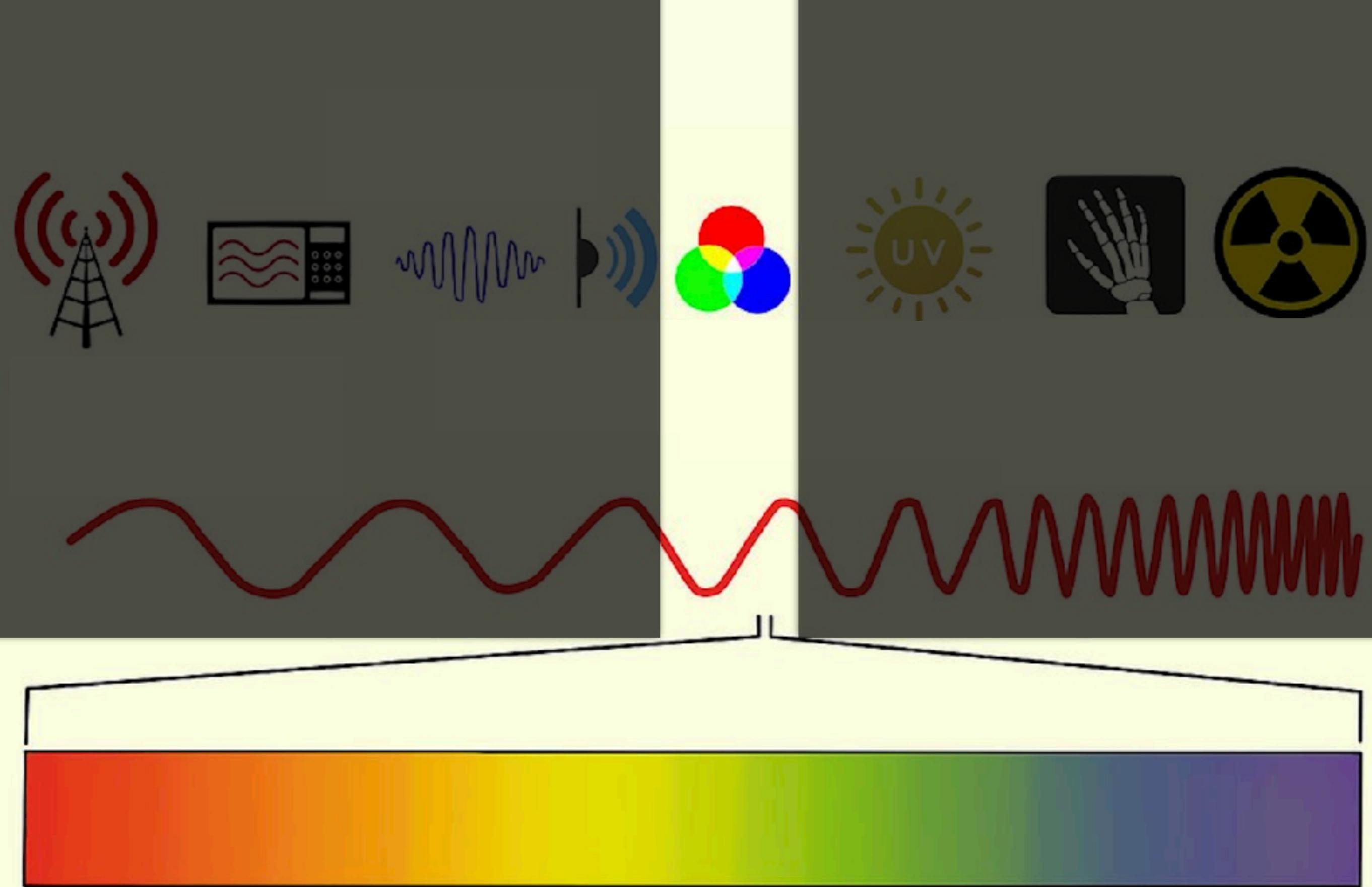


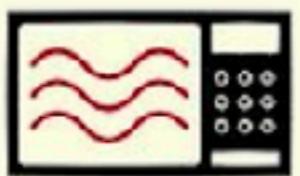


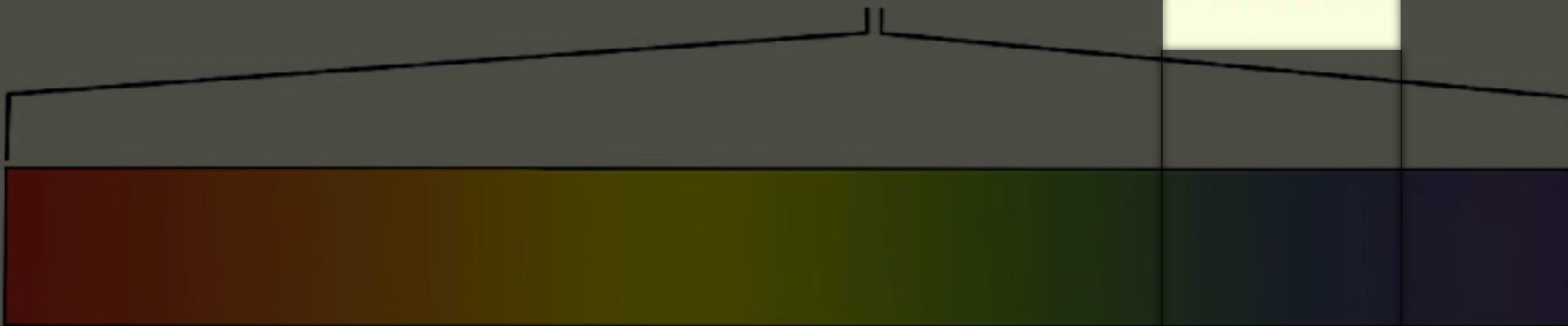
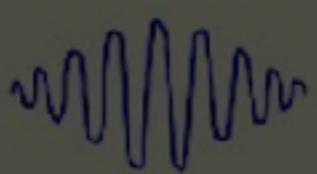
宇宙加速膨胀
10⁻³⁶秒内膨胀了10²⁶倍
温度从10³²度下降到1千万度
光子，电子

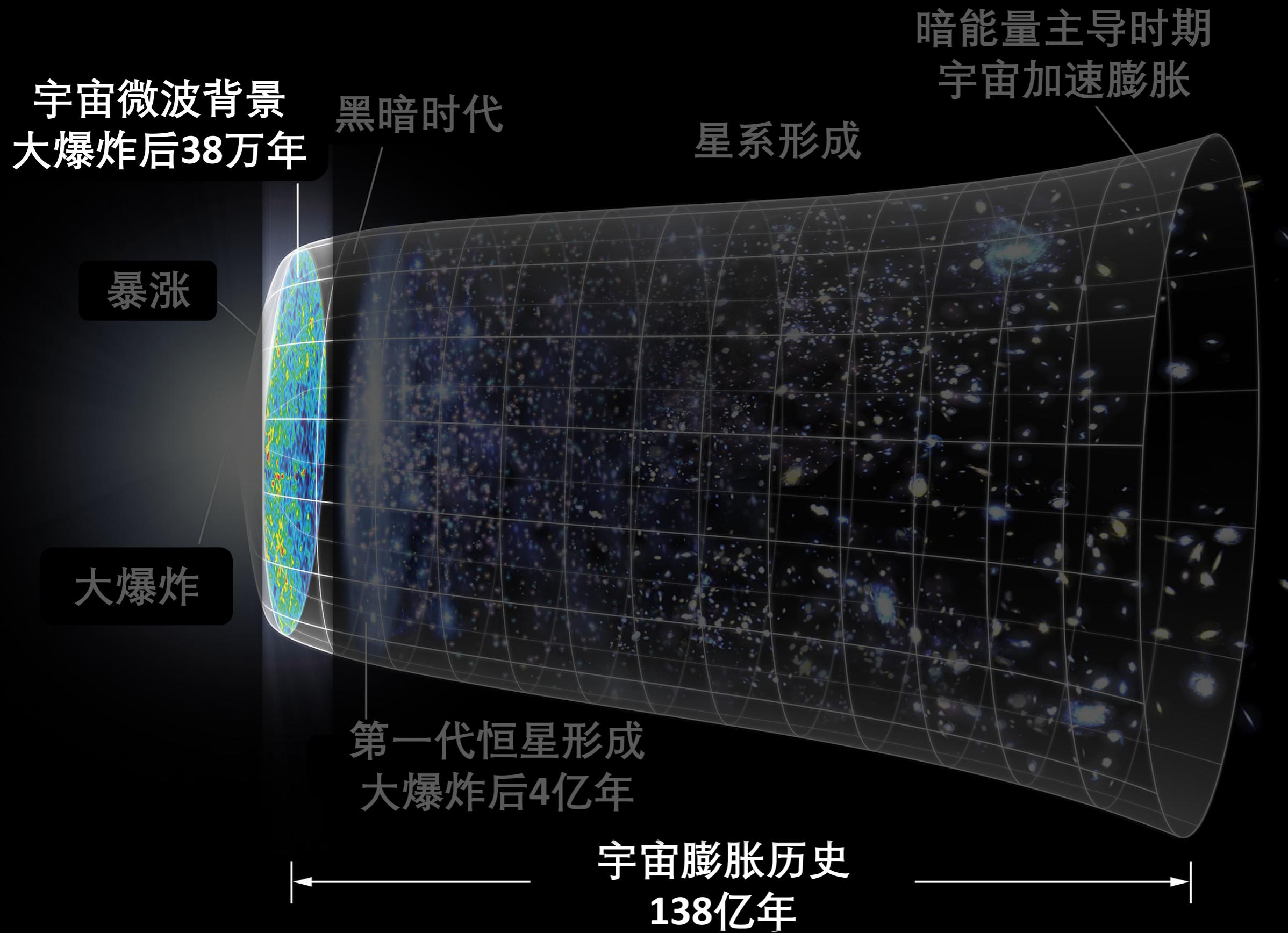


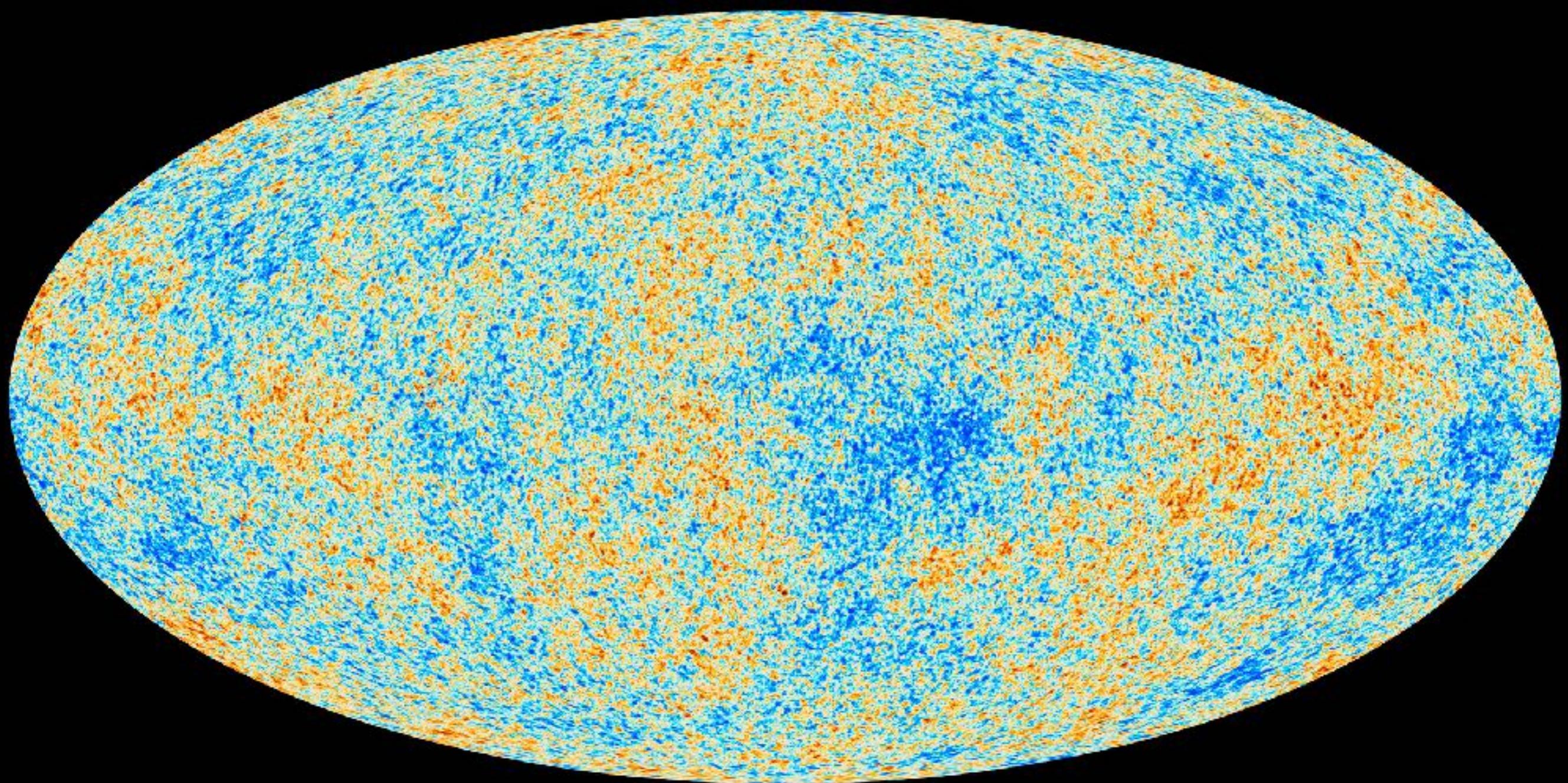


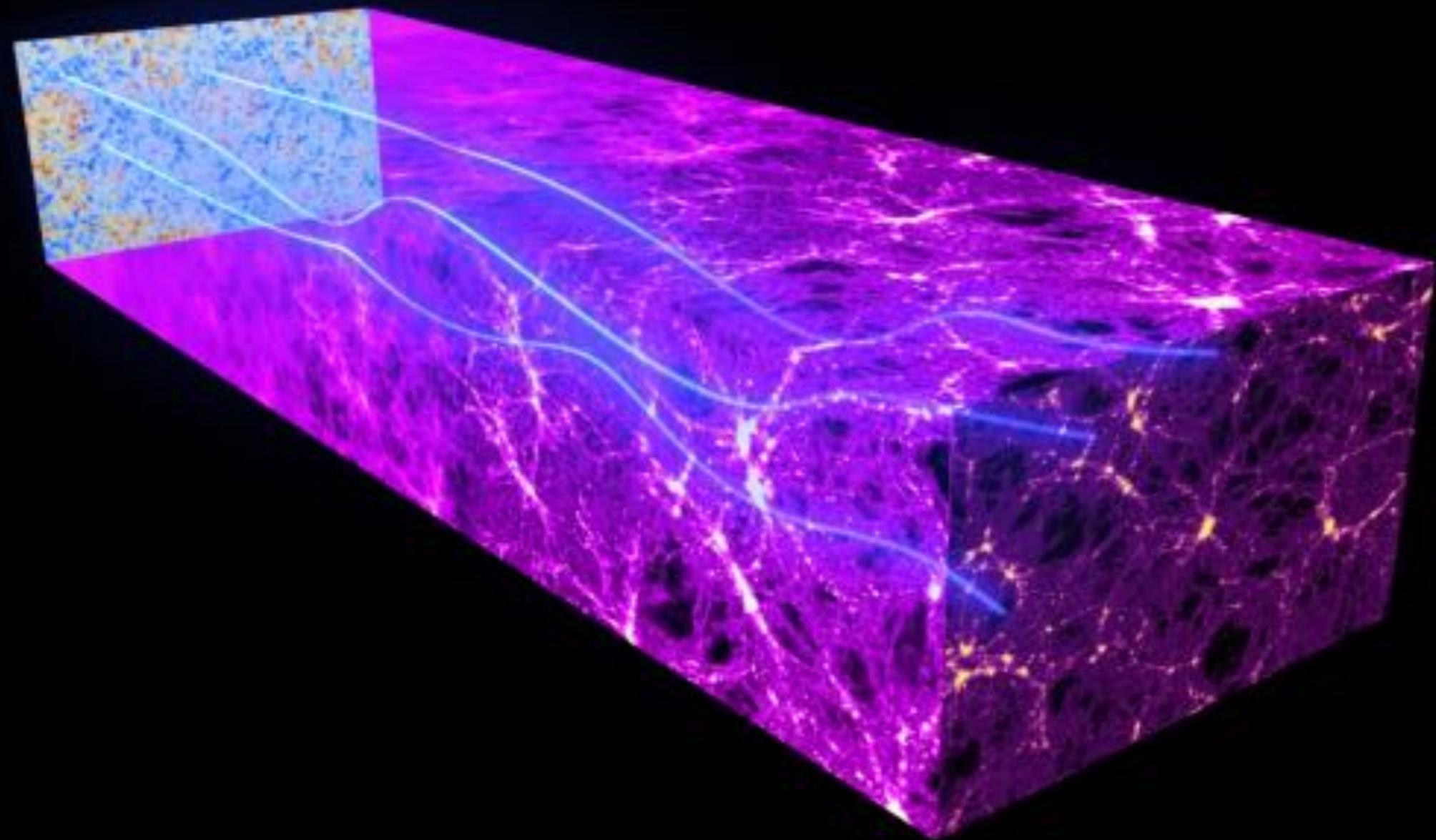










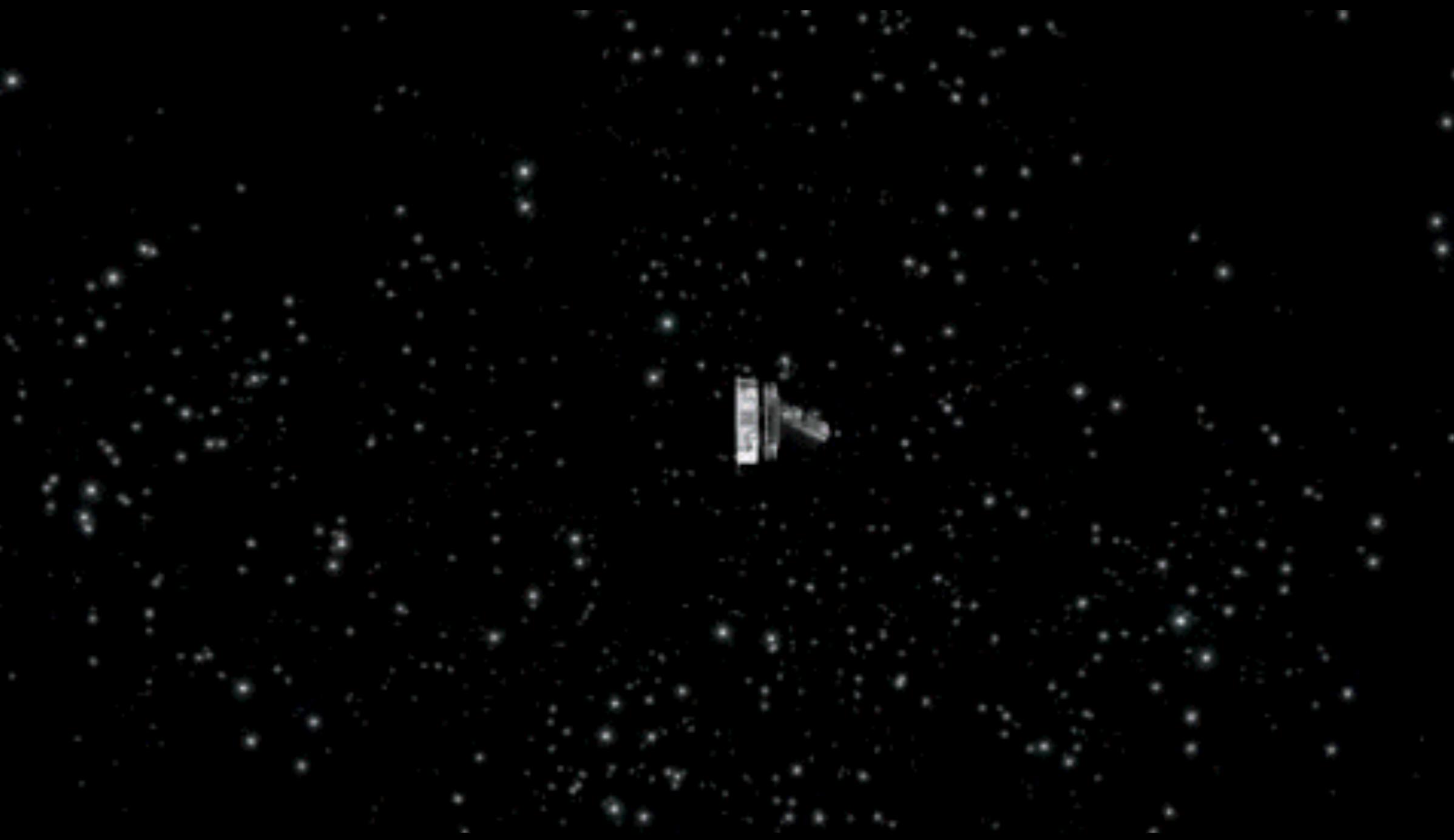


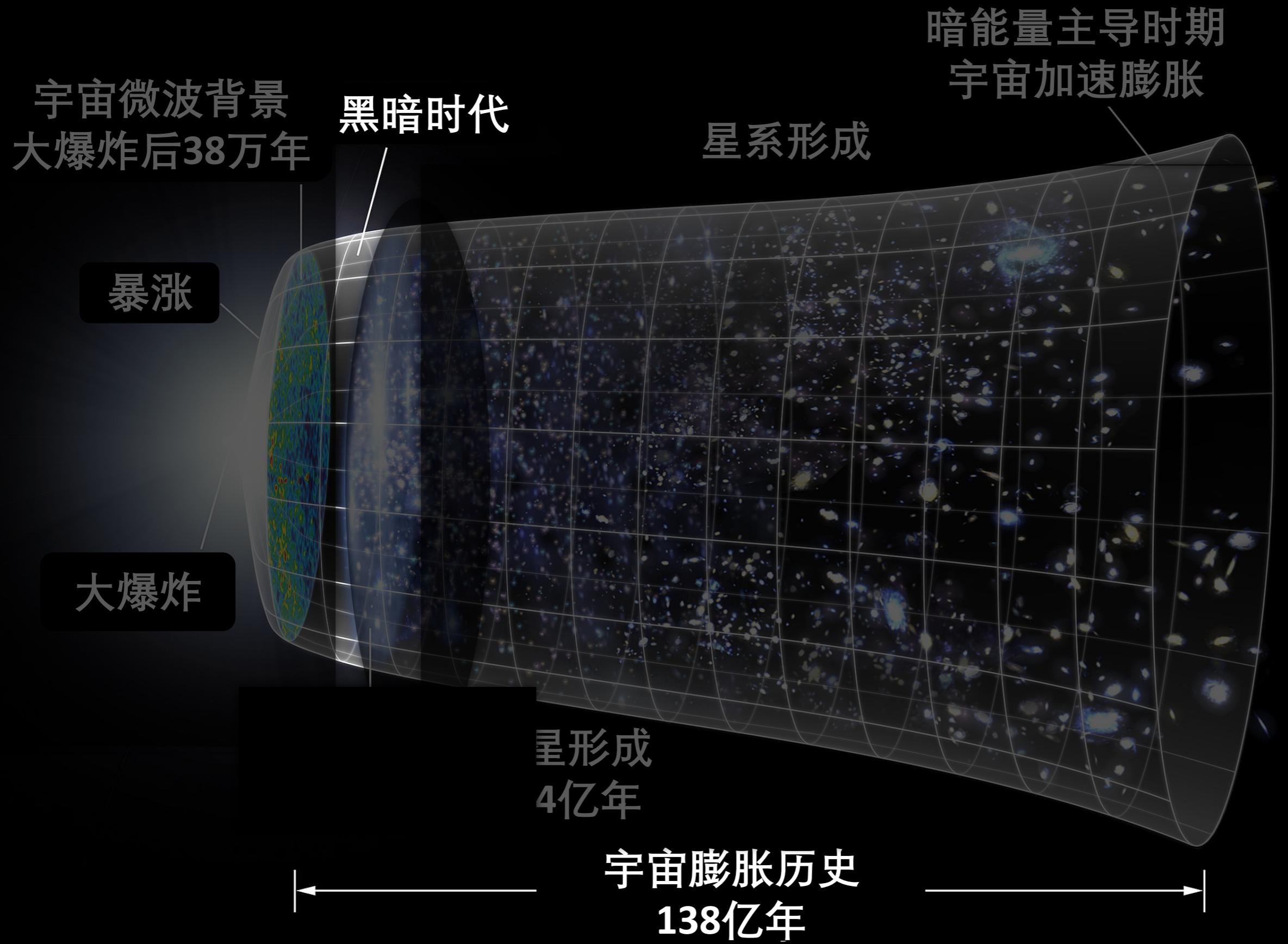


彭齐亚斯和威尔逊

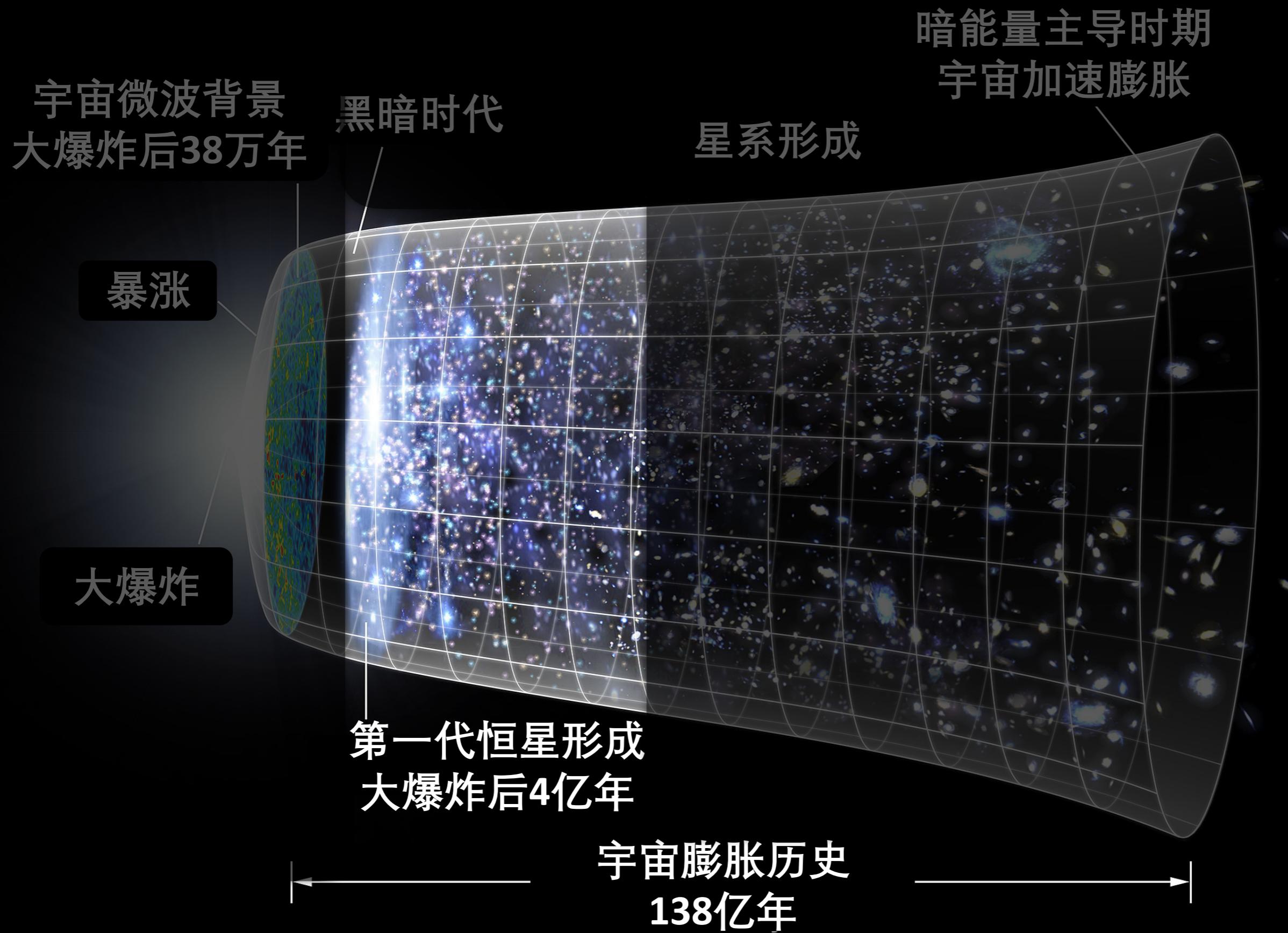


PIXELB0R



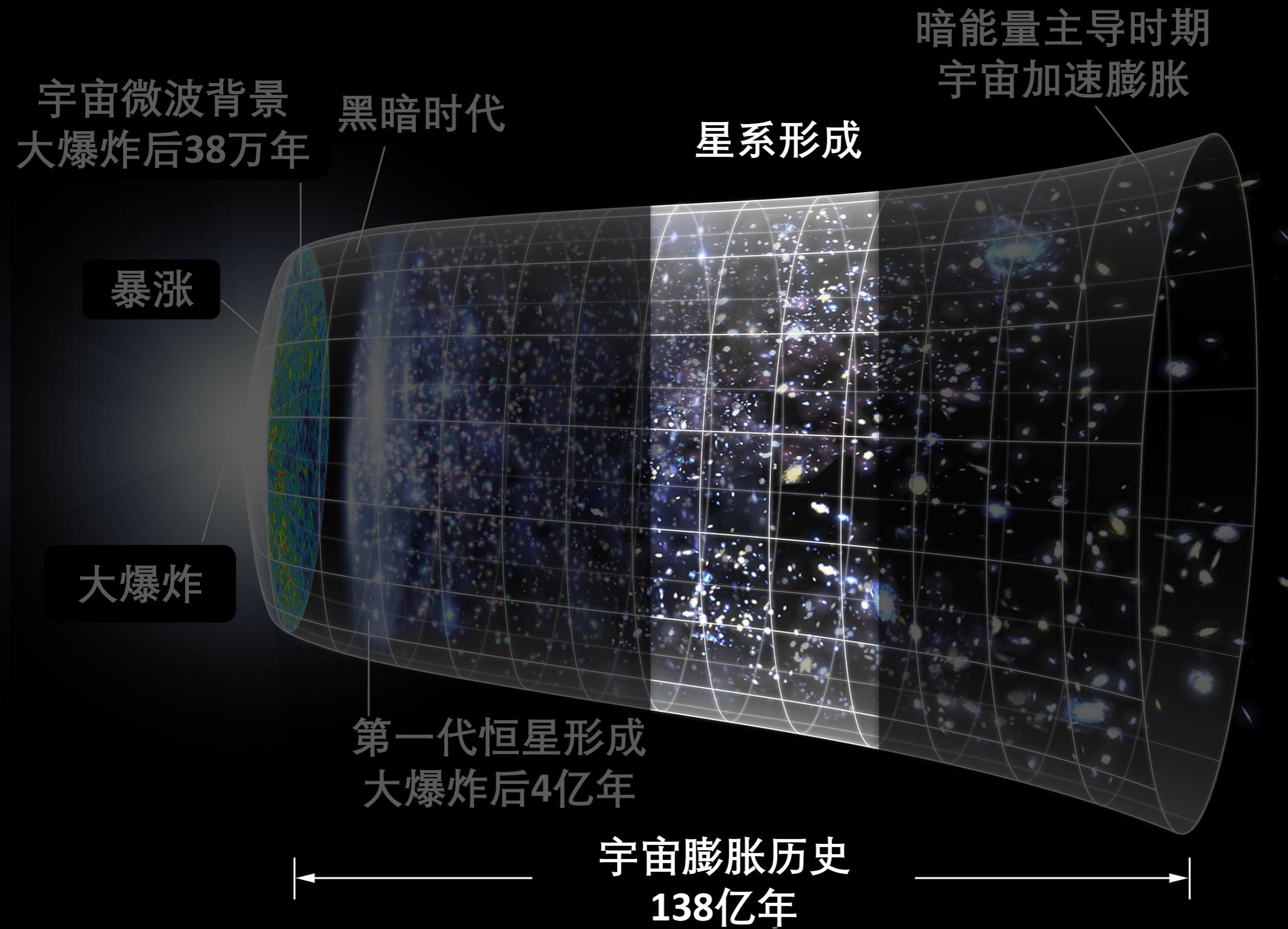


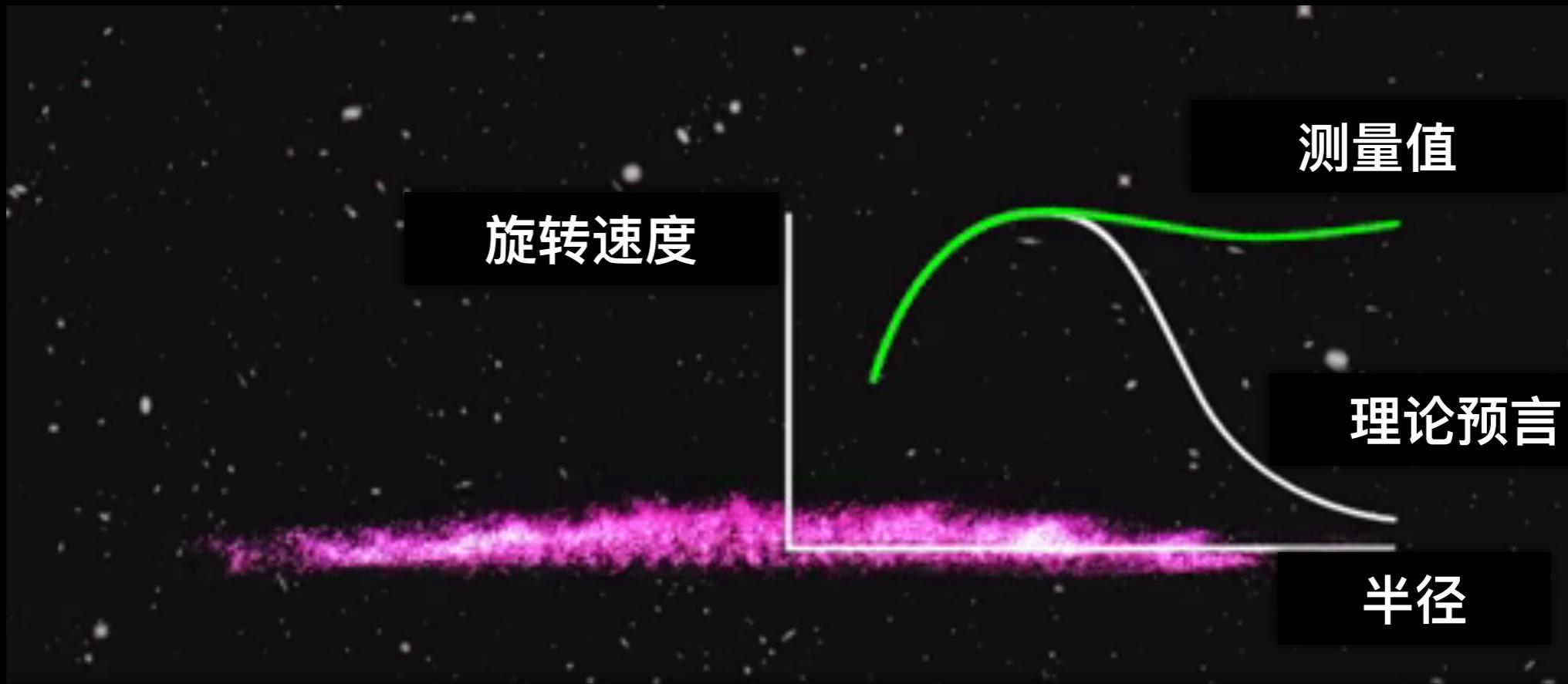
宇宙黑暗时代





宇宙黎明





暗物质：宇宙结构的生命摇篮

暗物质

普通物质

A photograph of the night sky, dominated by the bright, glowing band of the Milky Way galaxy. The galaxy's core is visible in the center-right, with a dense concentration of stars and a distinct orange-yellow hue. The surrounding space is filled with numerous smaller stars of varying colors, mostly blue and white, against a dark, almost black background.

银河系
直径10万光年以上



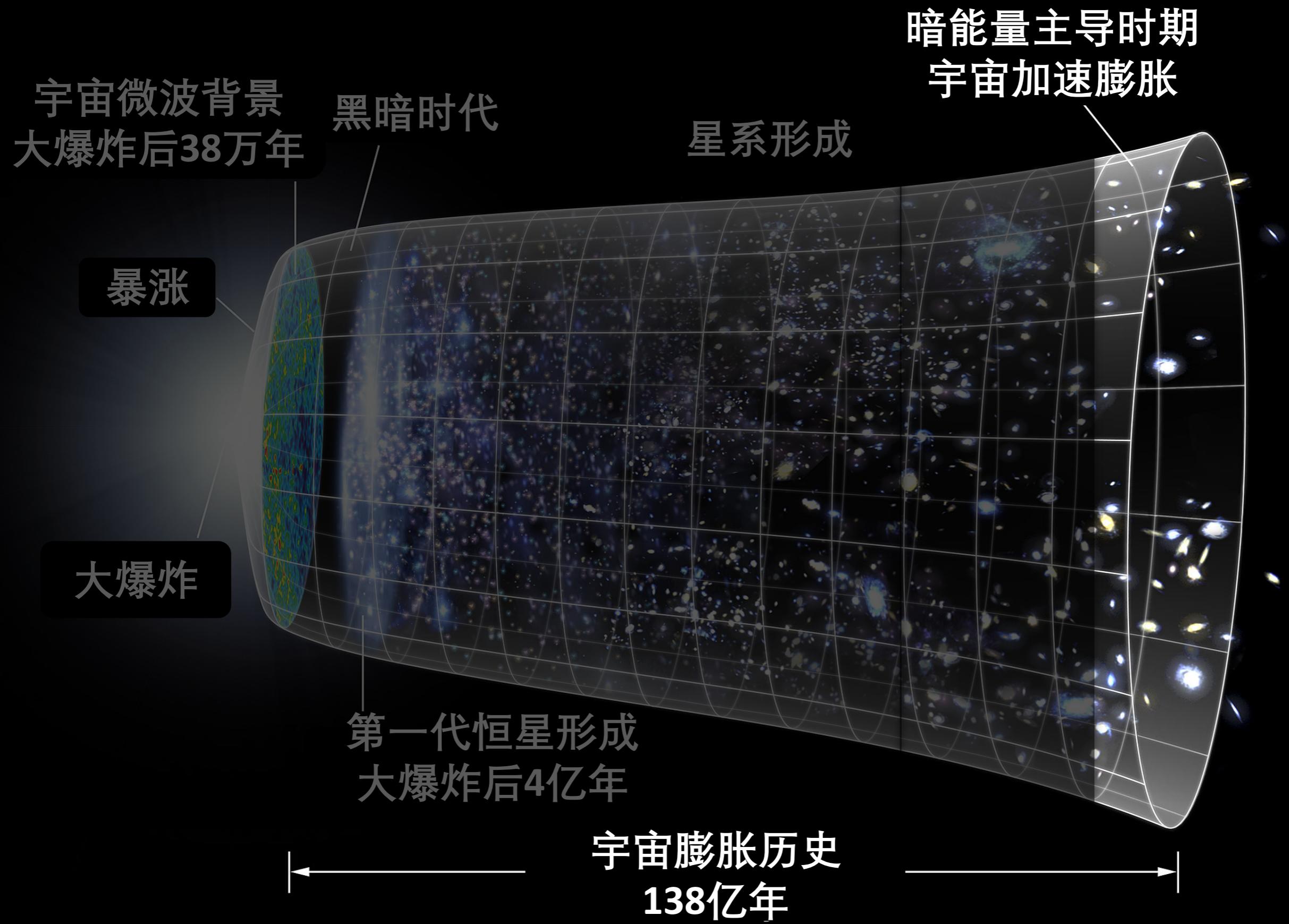
大麦哲伦云
距地球16万光年

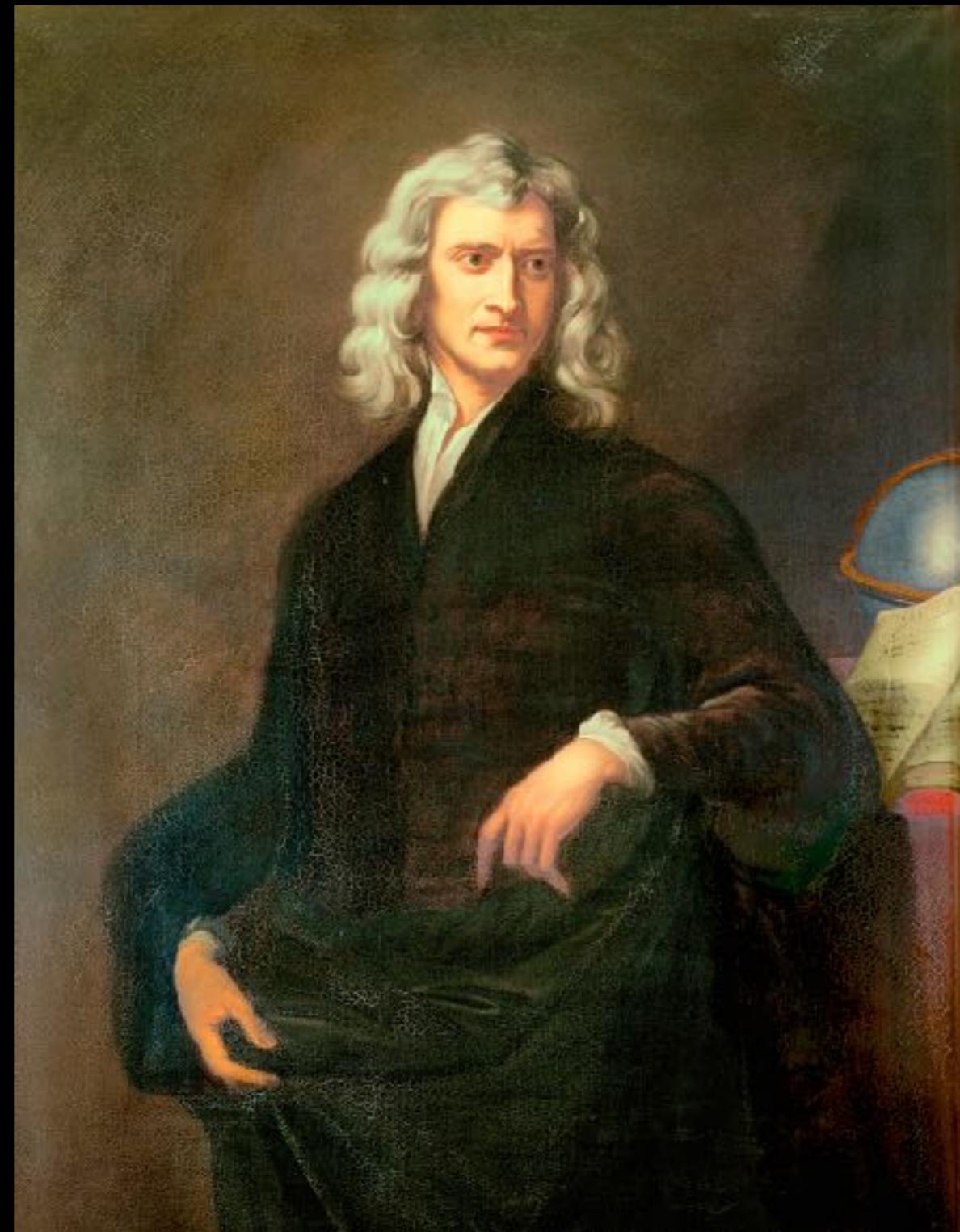


仙女座星系
距地球250万光年

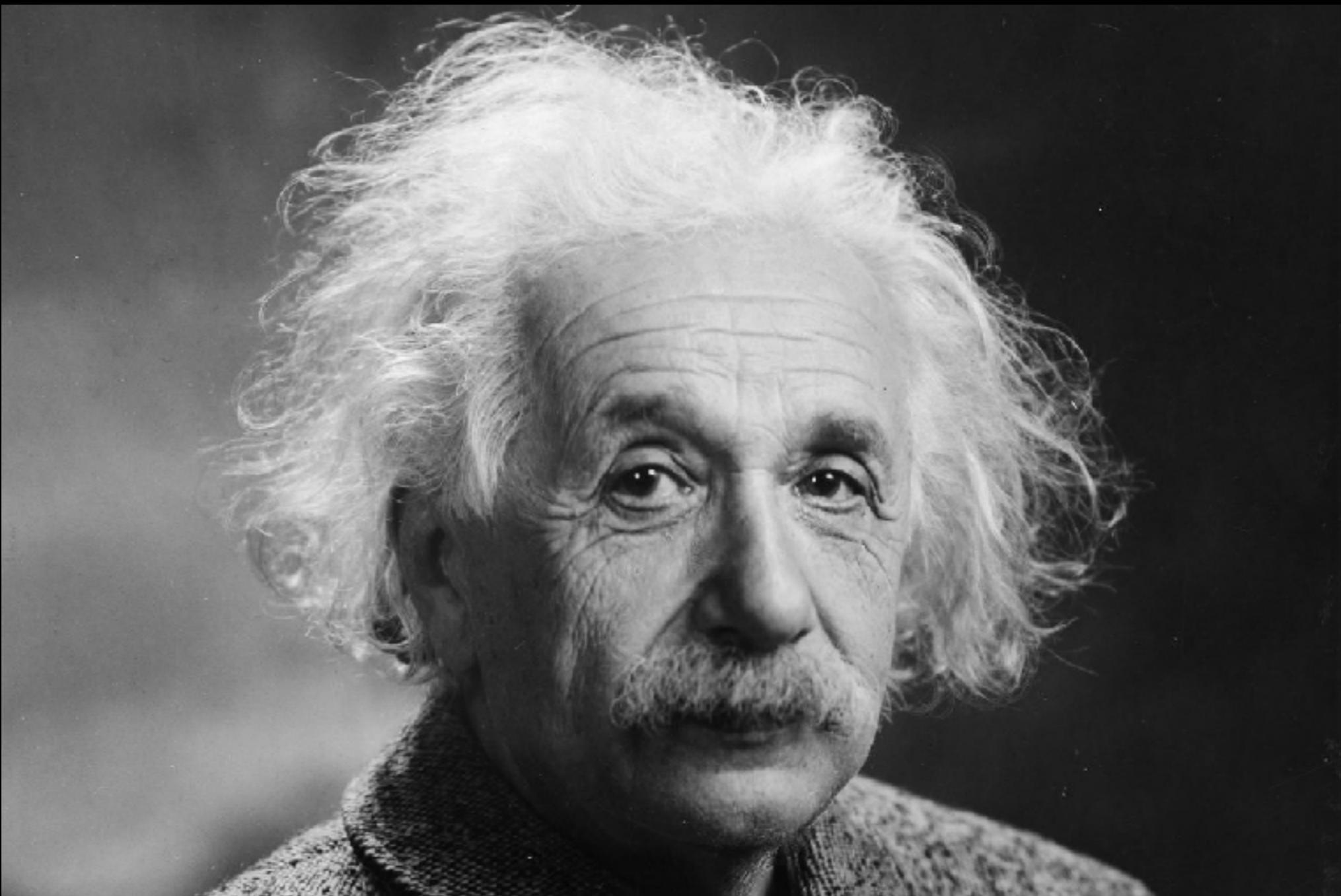


风车星系（大熊座）
距地球2100万光年

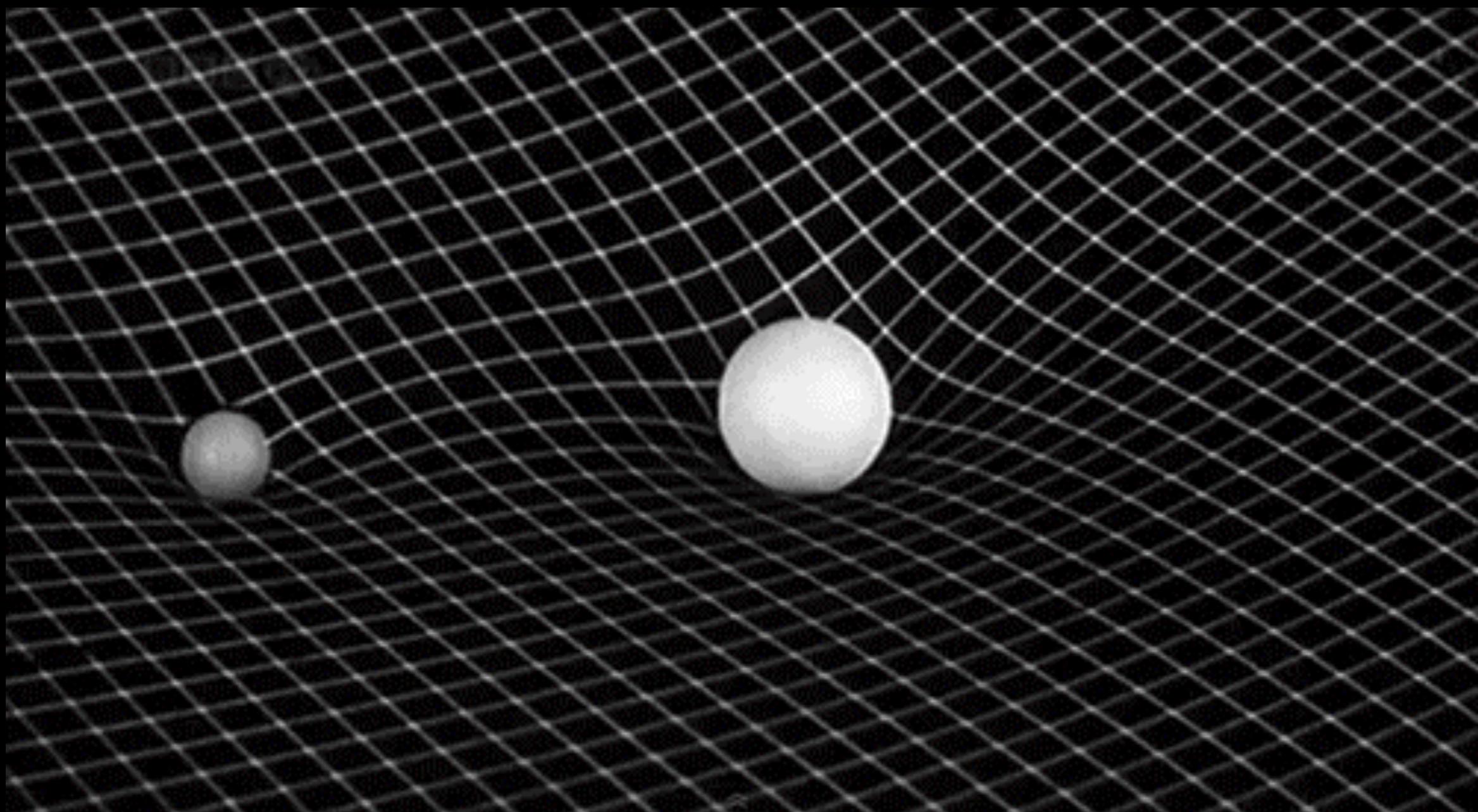




牛顿 (1643-1727)



爱因斯坦 (1879-1955)



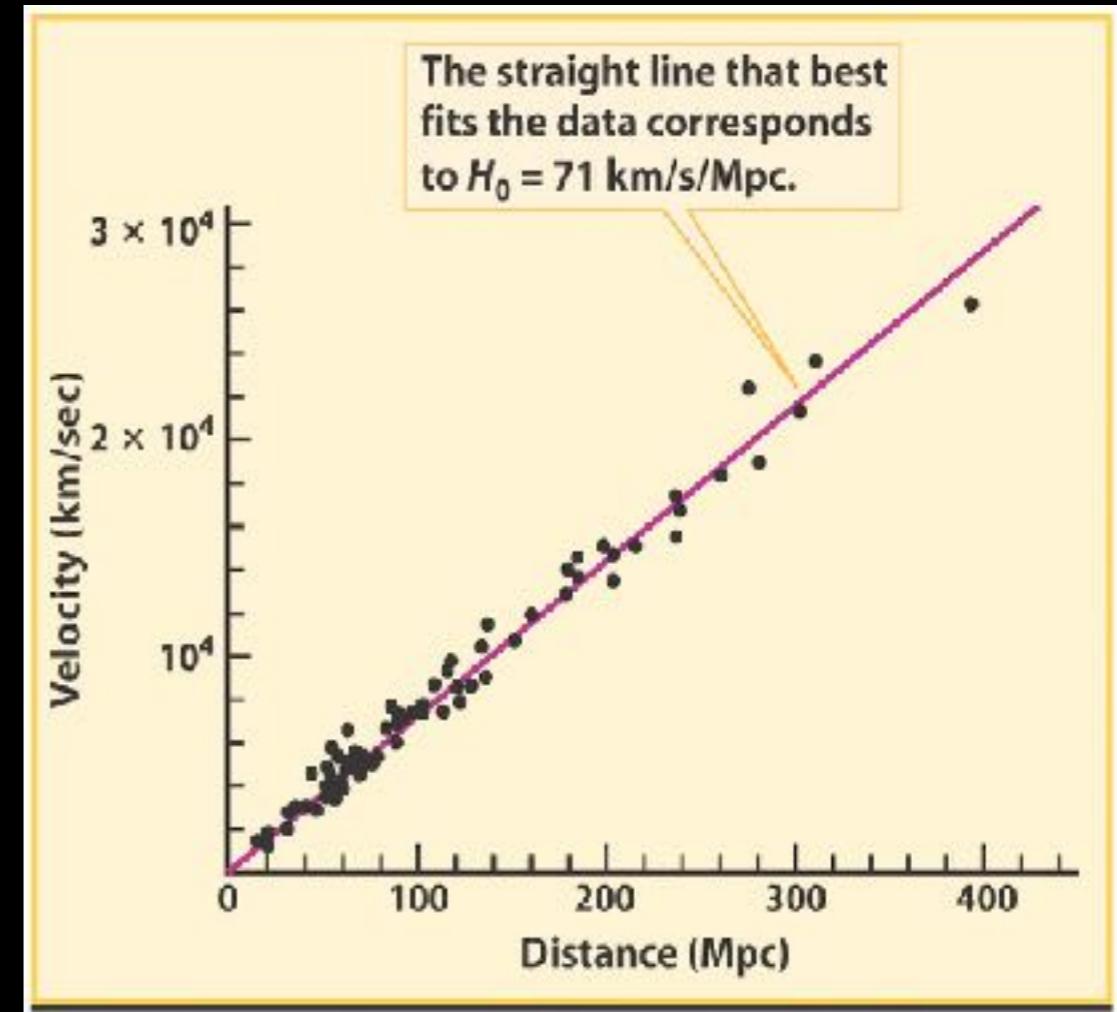


$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = 8\pi GT_{\mu\nu}$$

时空曲率 = 物质分₊宇宙学常数



哈勃 (1889-1953)



宇宙膨胀



Photo: Axel Zabelich, Copyright © Nobel Media AB

Saul Perlmutter

Photo: Belinda Pratten, Australian National University

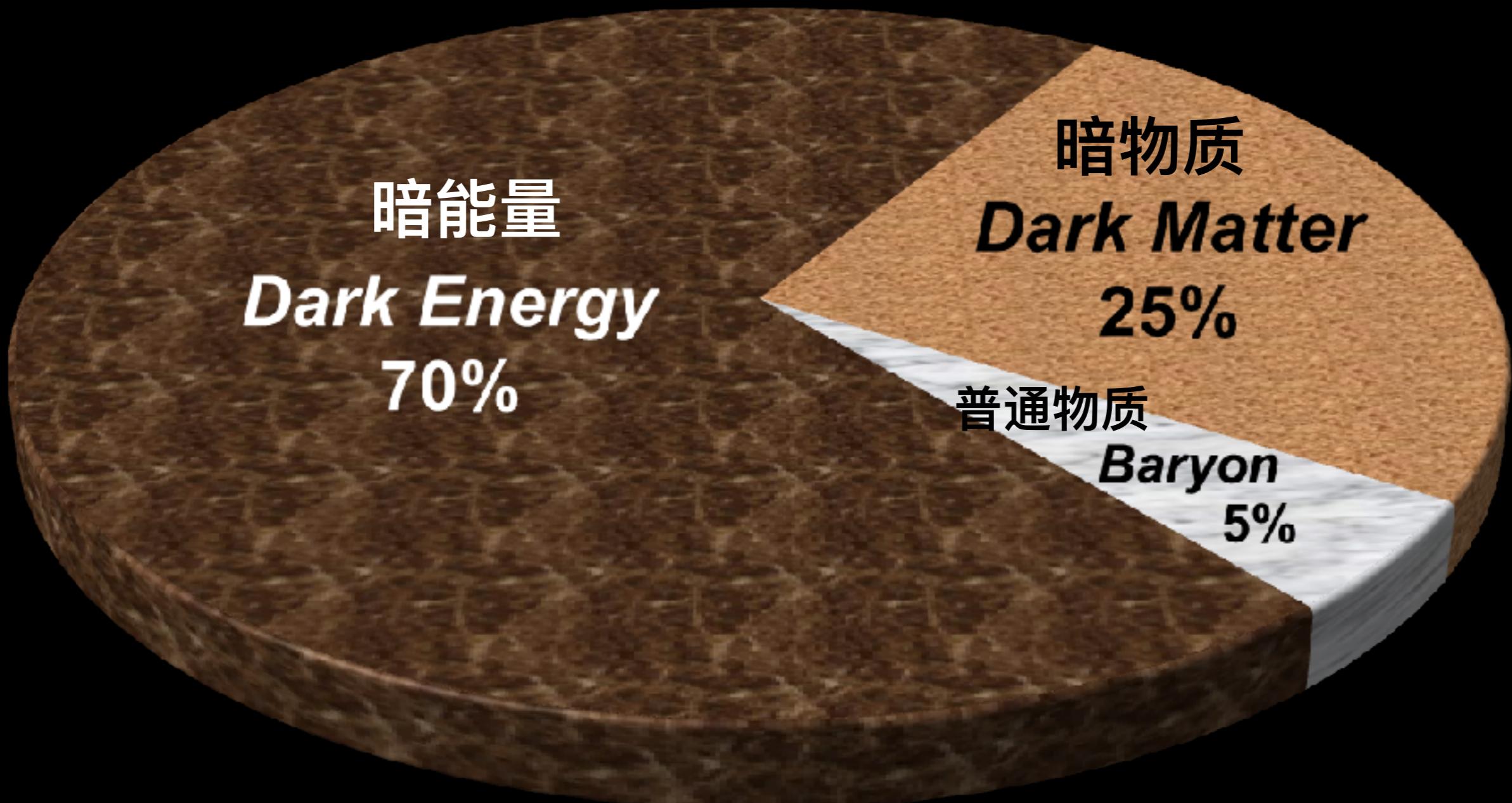
Brian P. Schmidt

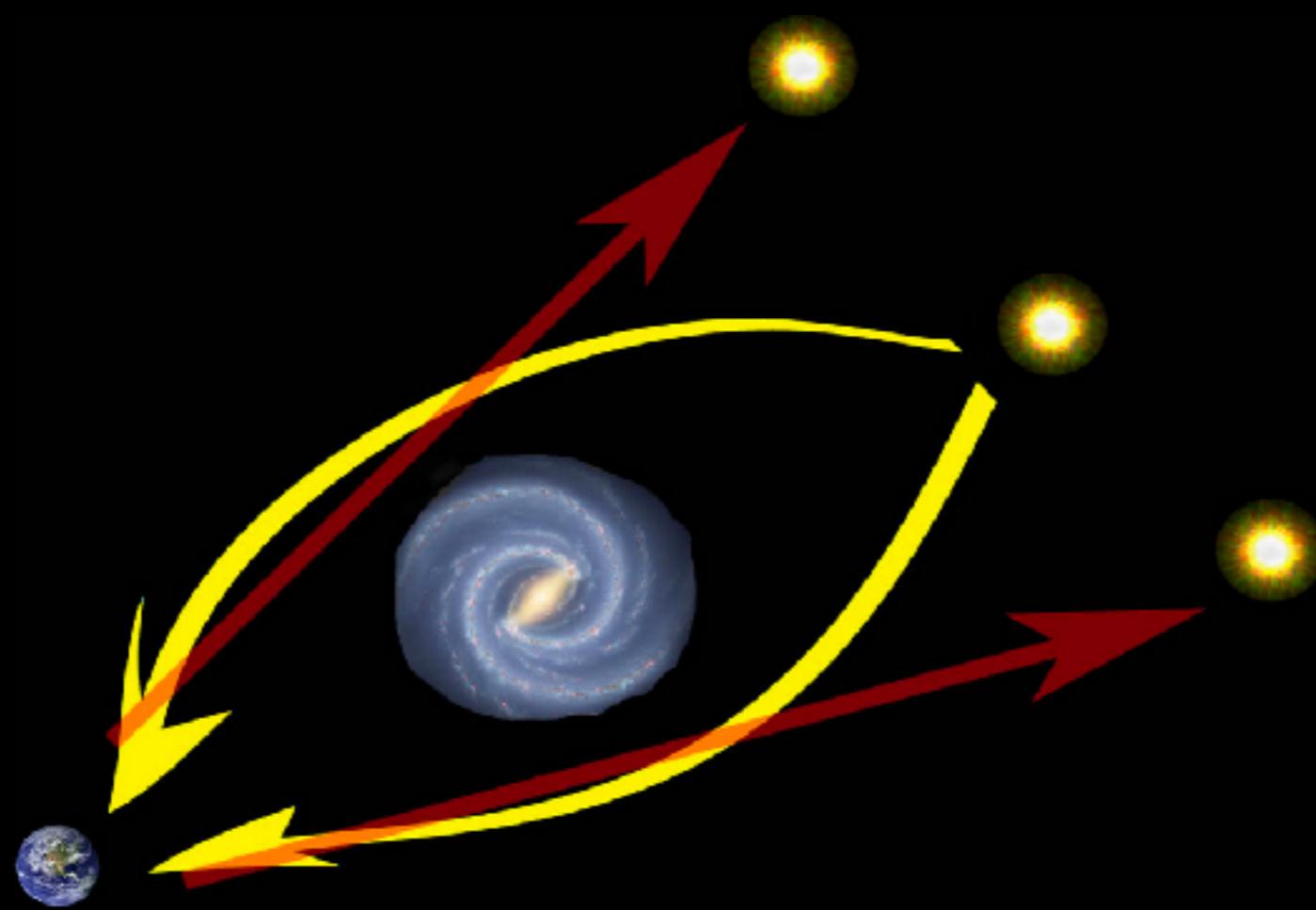
Photo: Homewood Photography

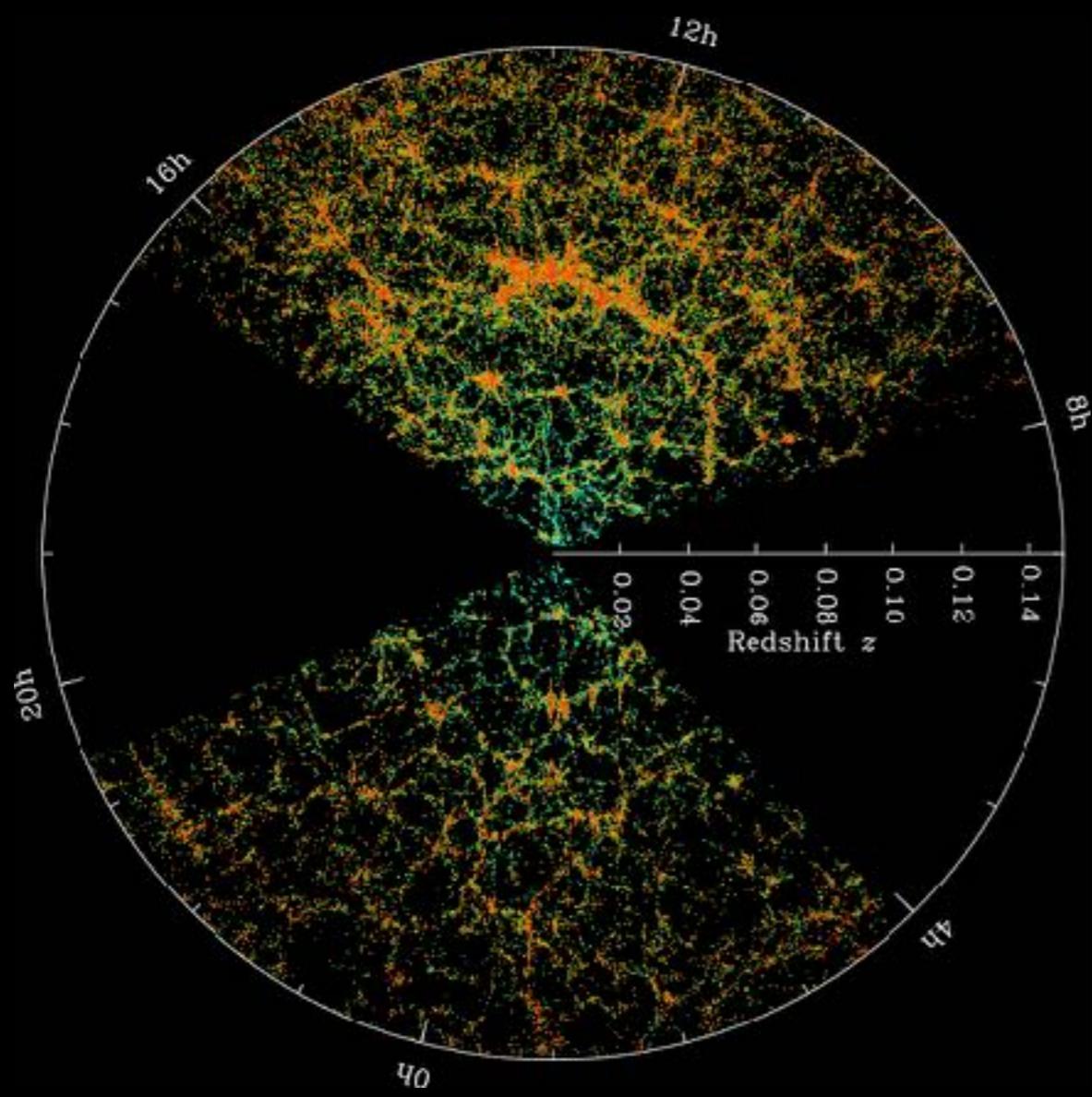
Adam G. Riess



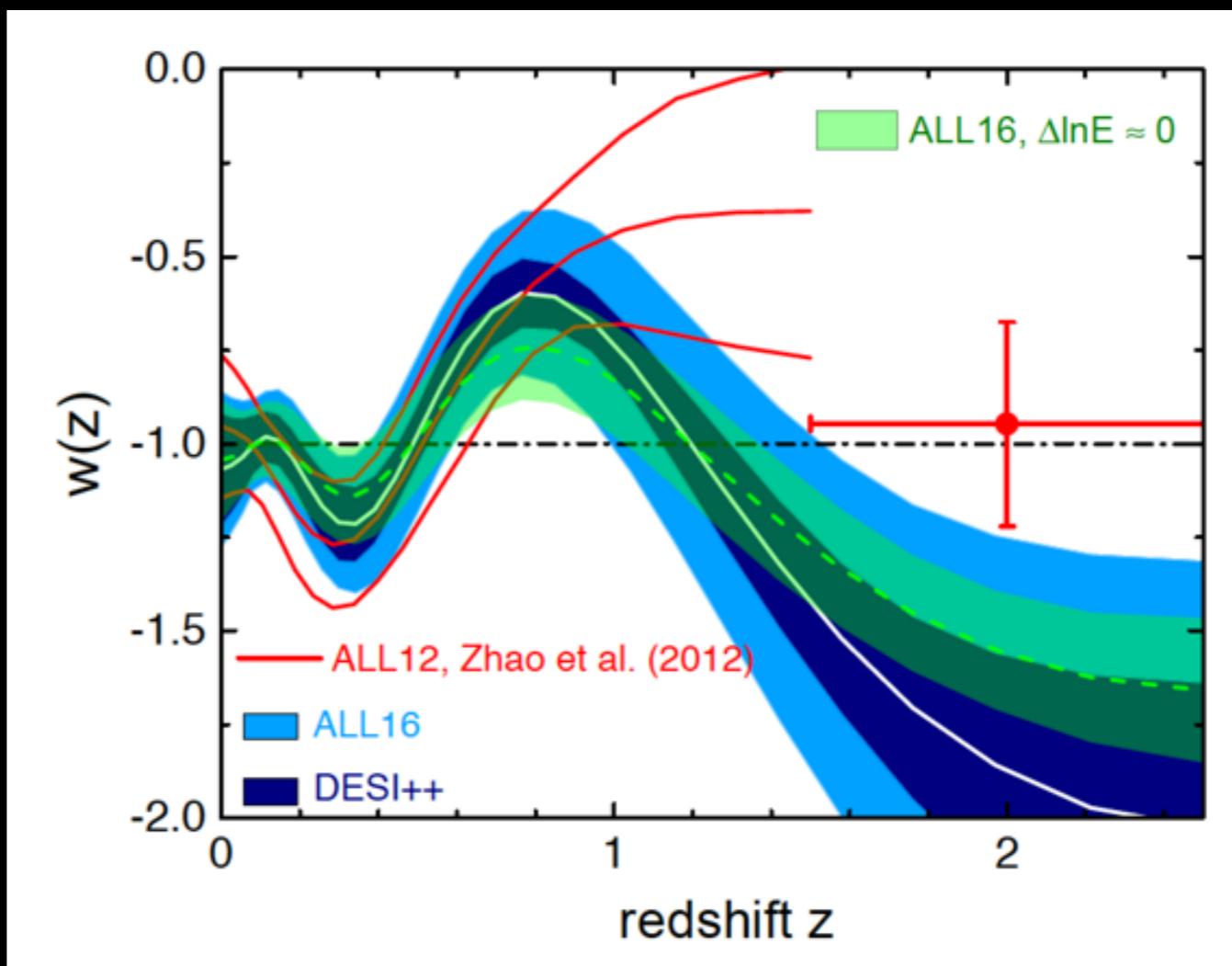
宇宙加速膨胀！

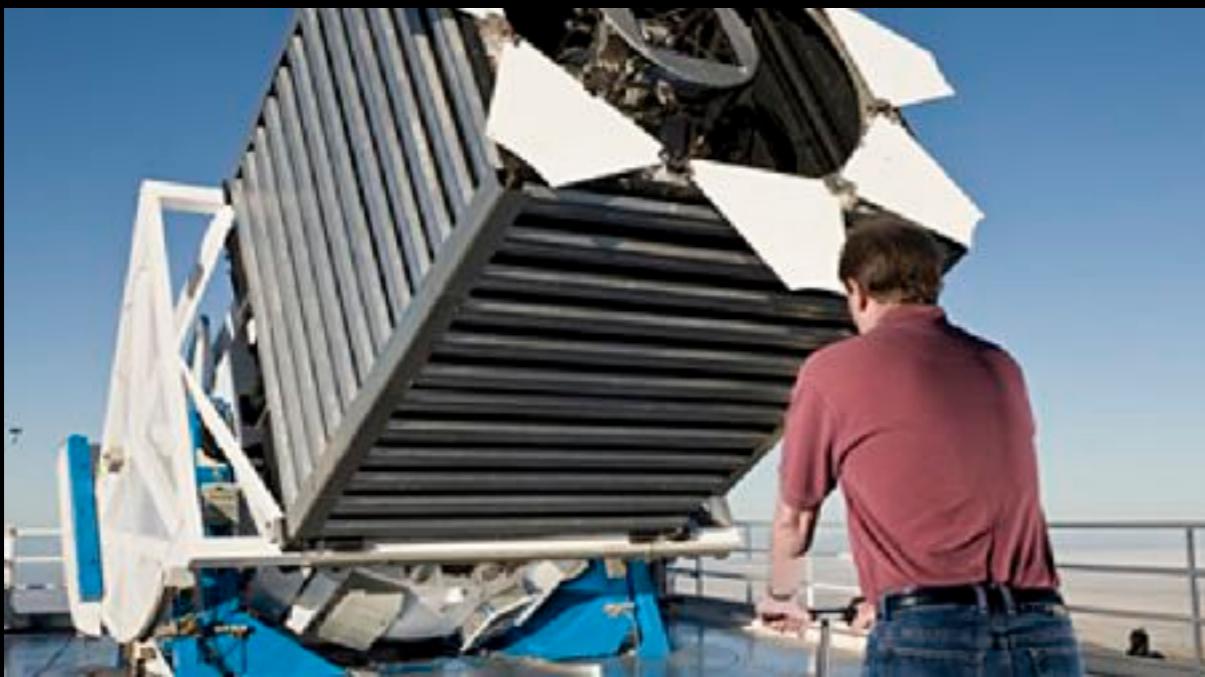




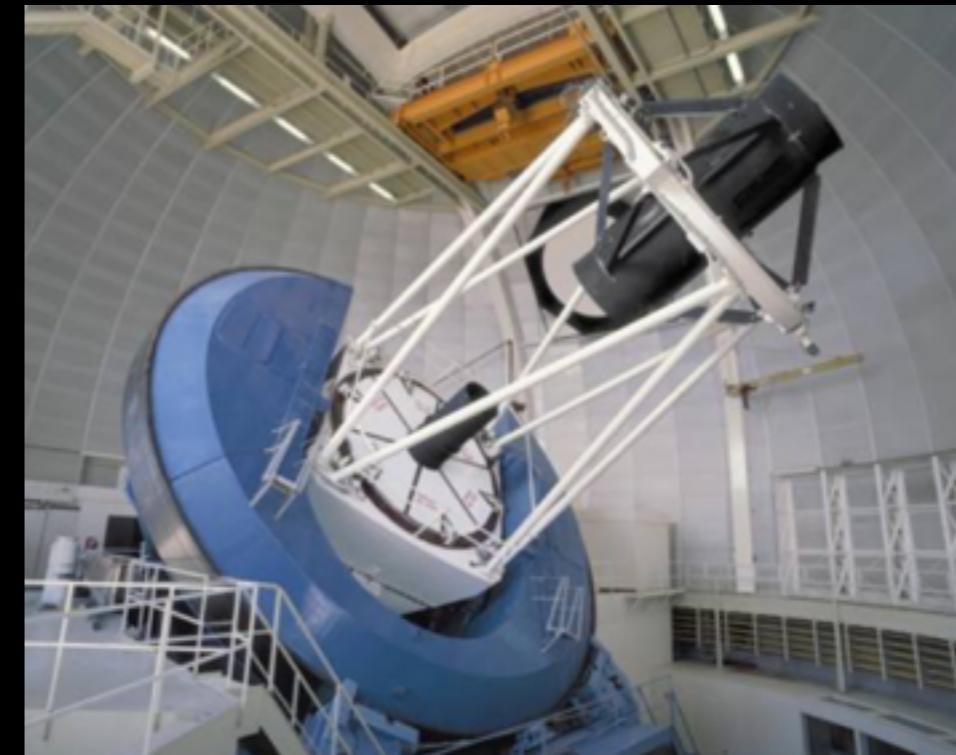


BOSS项目





SDSS, 2.5米 (目前)



DESI, 4米 (2019-)



LSST, 10米 (2020-)



TMT, 30米 (2025? -)