

EPS理论与暗物质晕的 质量增长历史

导师：高亮

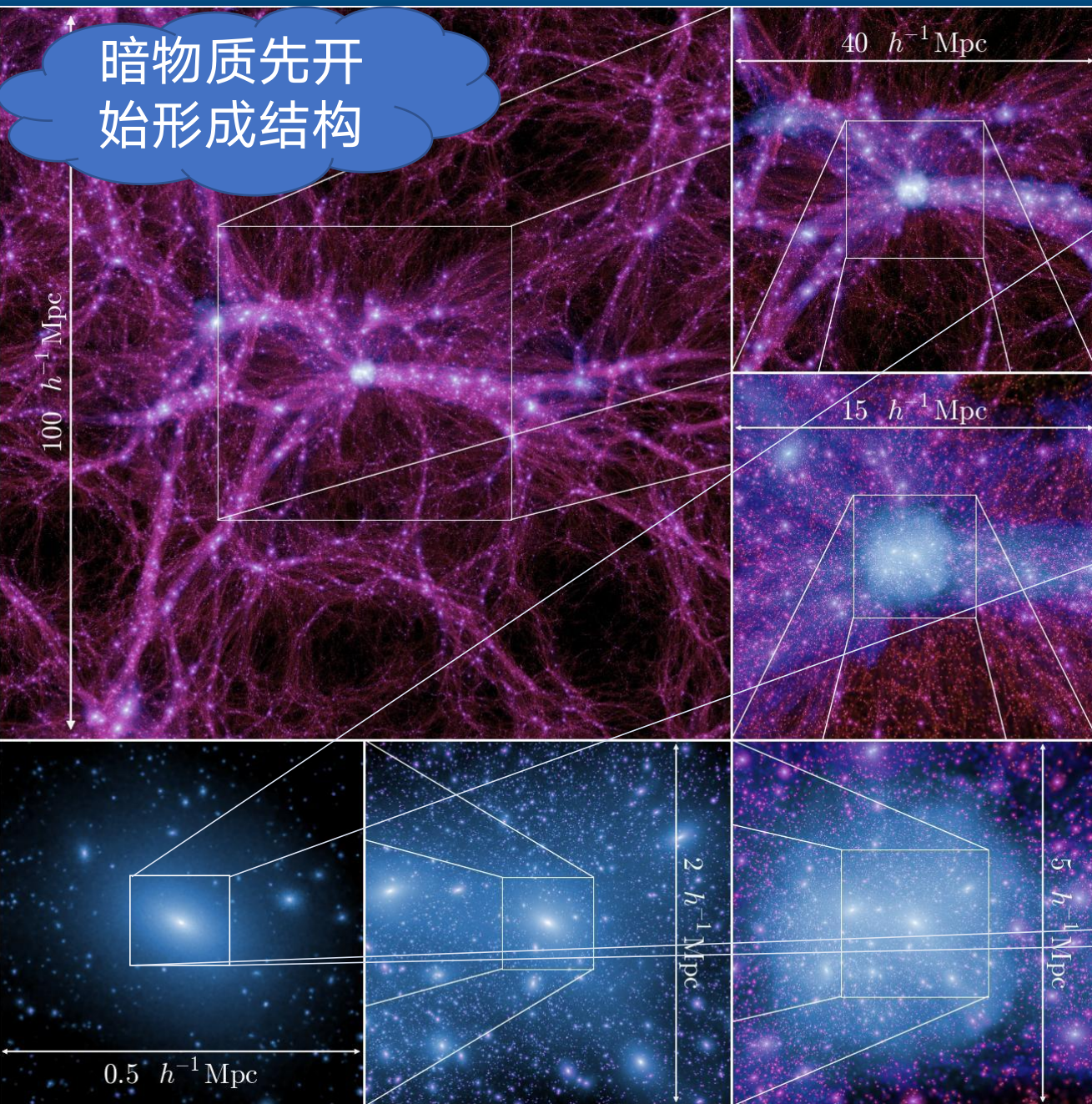
报告学生：刘奕舟

arXiv:2303.15894

报告时间：23.4.18

研究背景： Λ CDM标准宇宙学模型

暗物质先开始形成结构

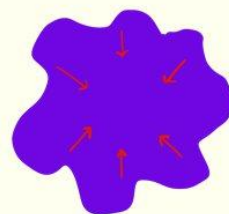


然后重子物质落入暗物质构成的暗晕从而形成星系

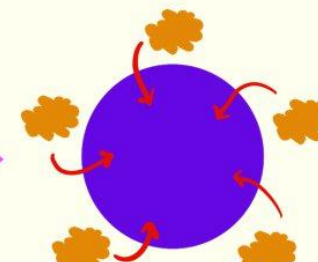
Theory Of Galaxy Formation

(not to scale)

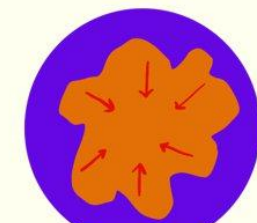
Dark Matter: purple
Gas: orange
Stars: yellow



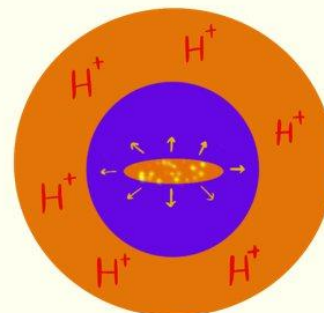
DM Halo collapse



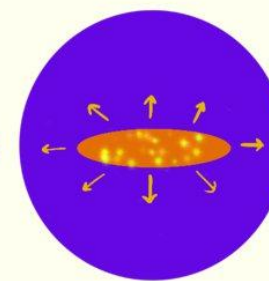
Gas infall & heating



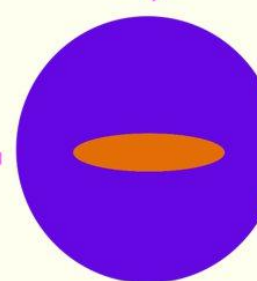
Gas cools + collapses



Ionised Hydrogen



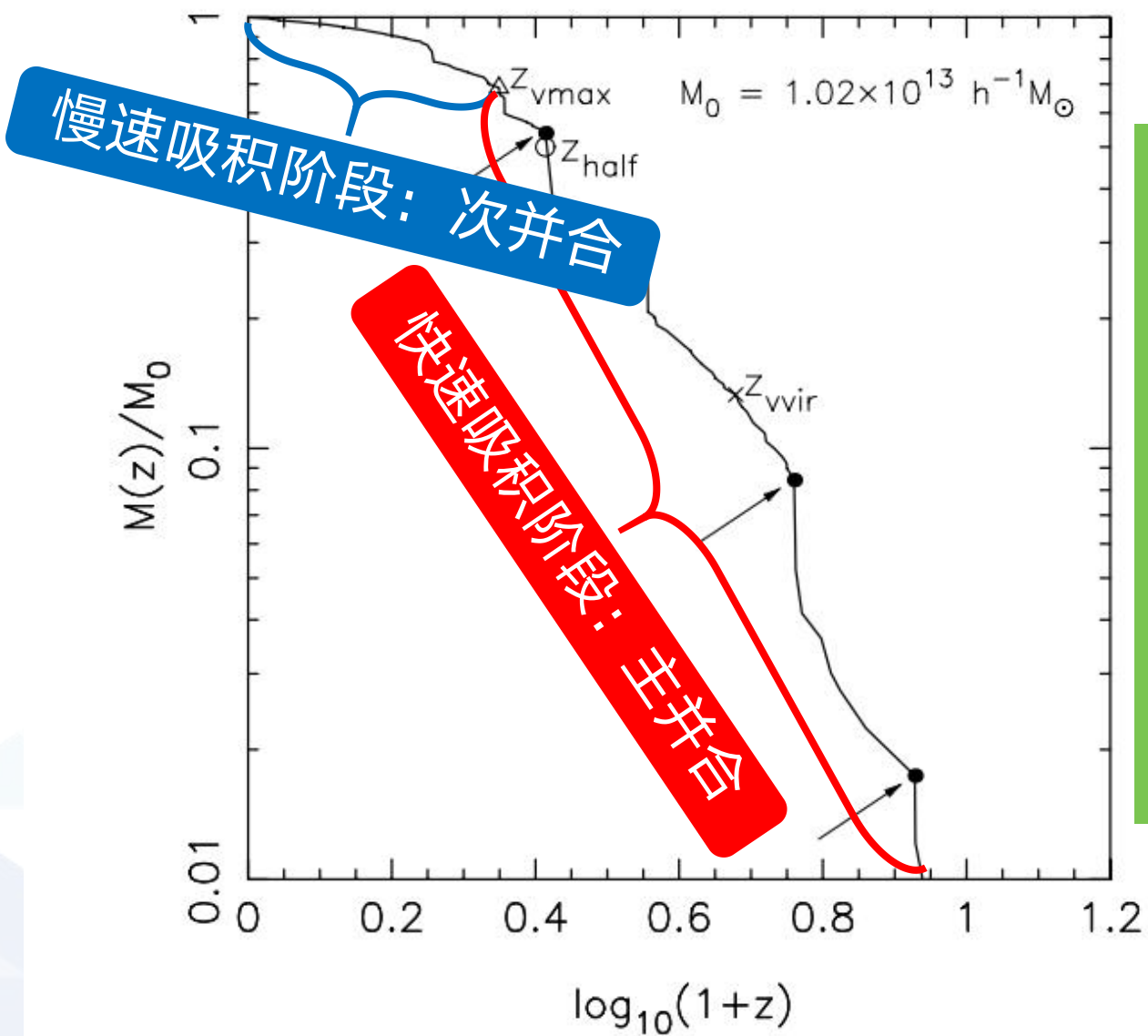
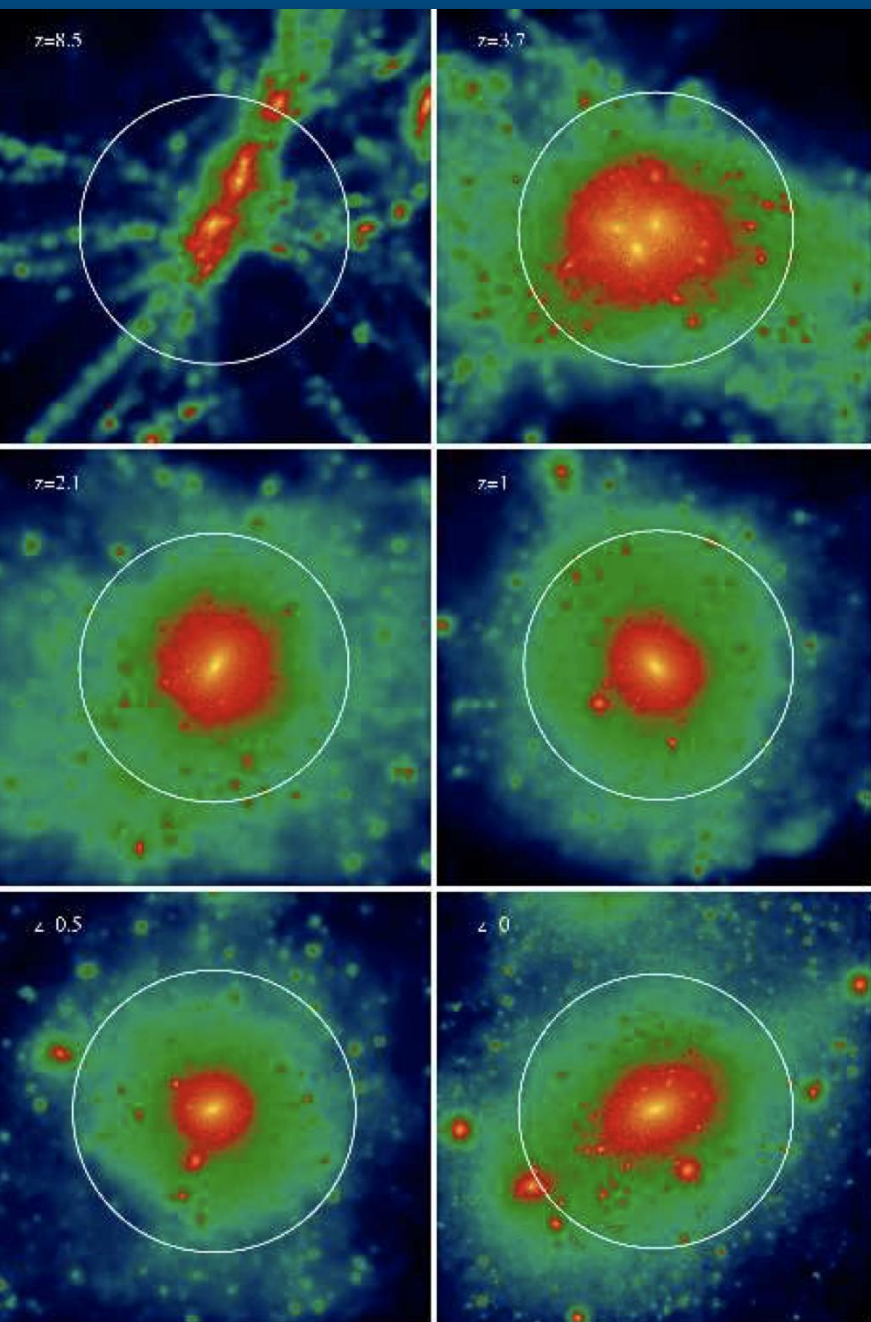
Star formation + feedback



Dense gas clouds

Pratik Gandhi (@astrogandhi)

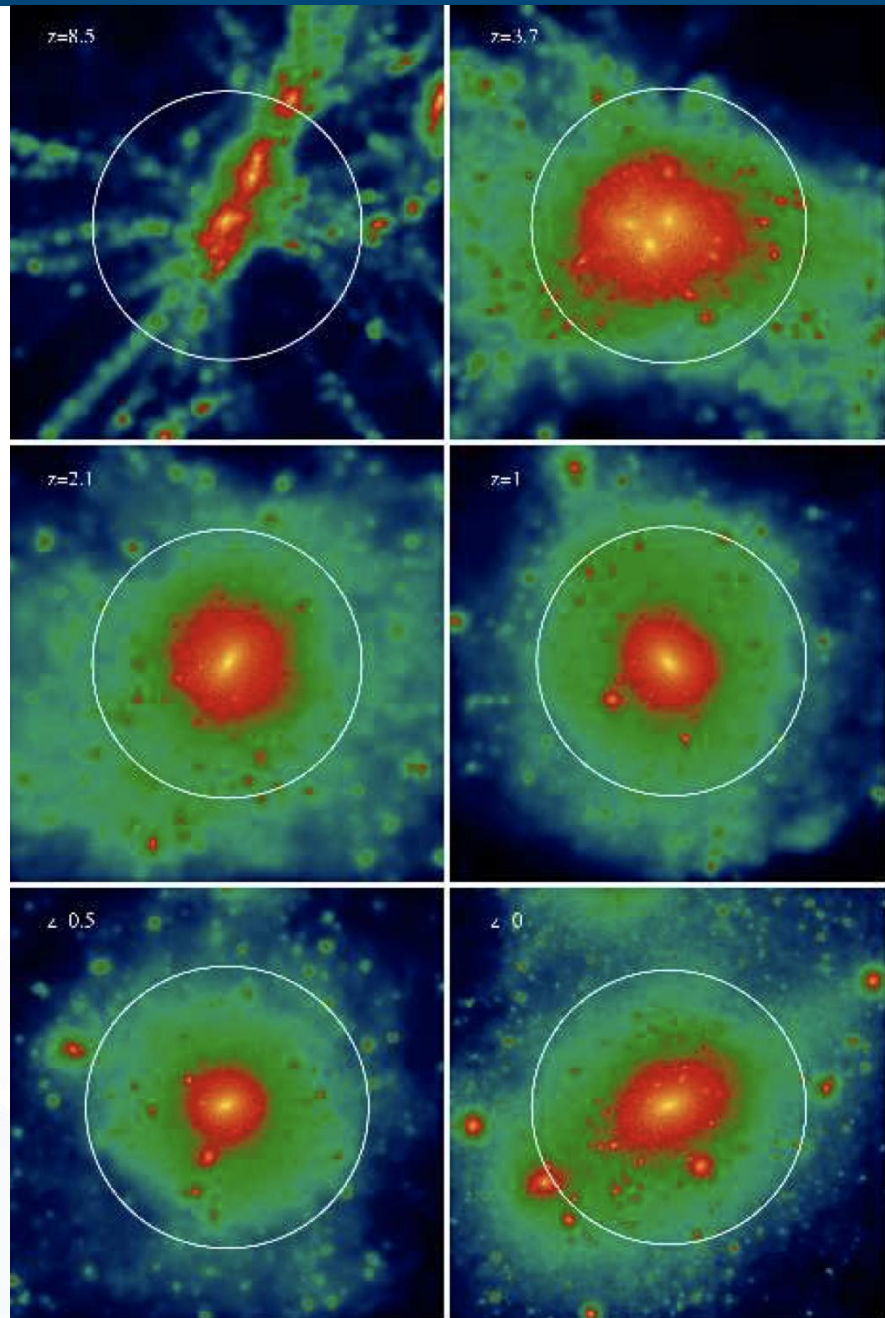
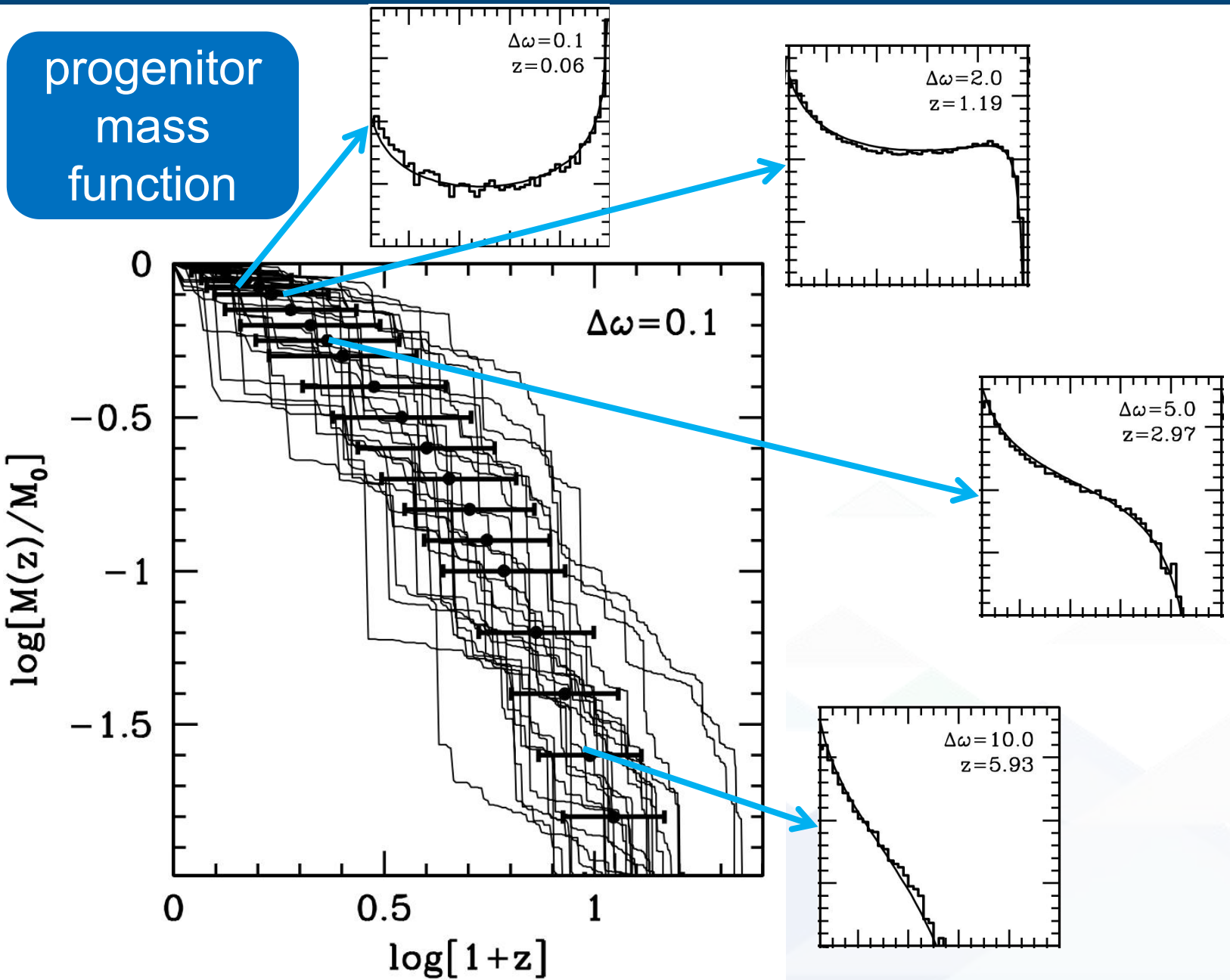
研究背景：N体模拟与暗晕演化



暗晕的质量增长历史

研究背景：EPS理论与暗晕祖先(progenitor)质量函数

progenitor mass function



研究背景：EPS理论与暗晕质量增长历史模型

Z体模拟

EPS理论

暗晕的增长历史模型

拟合模型：

- Wechsler et al. (2002)
- van den Bosch et al. (2002)
- Zhao et al. (2009)
- McBride et al. (2009)
- Giocoli et al. (2012)
- Ludlow et al. (2012)
- van den Bosch et al. (2014)

解析模型：

- Gao et al. (2005)
- Neistein et al. (2006)
- Correa et al. (2015)

优点：准确的描述复杂的引力系统

缺点：需要大量计算资源，不具有普适性

优点：计算量小很多，不受分辨率影响，具有普适性

缺点：不一定准确，因此需要被检验（动机）

研究背景：EPS理论与暗晕质量增长历史模型

Z体模拟

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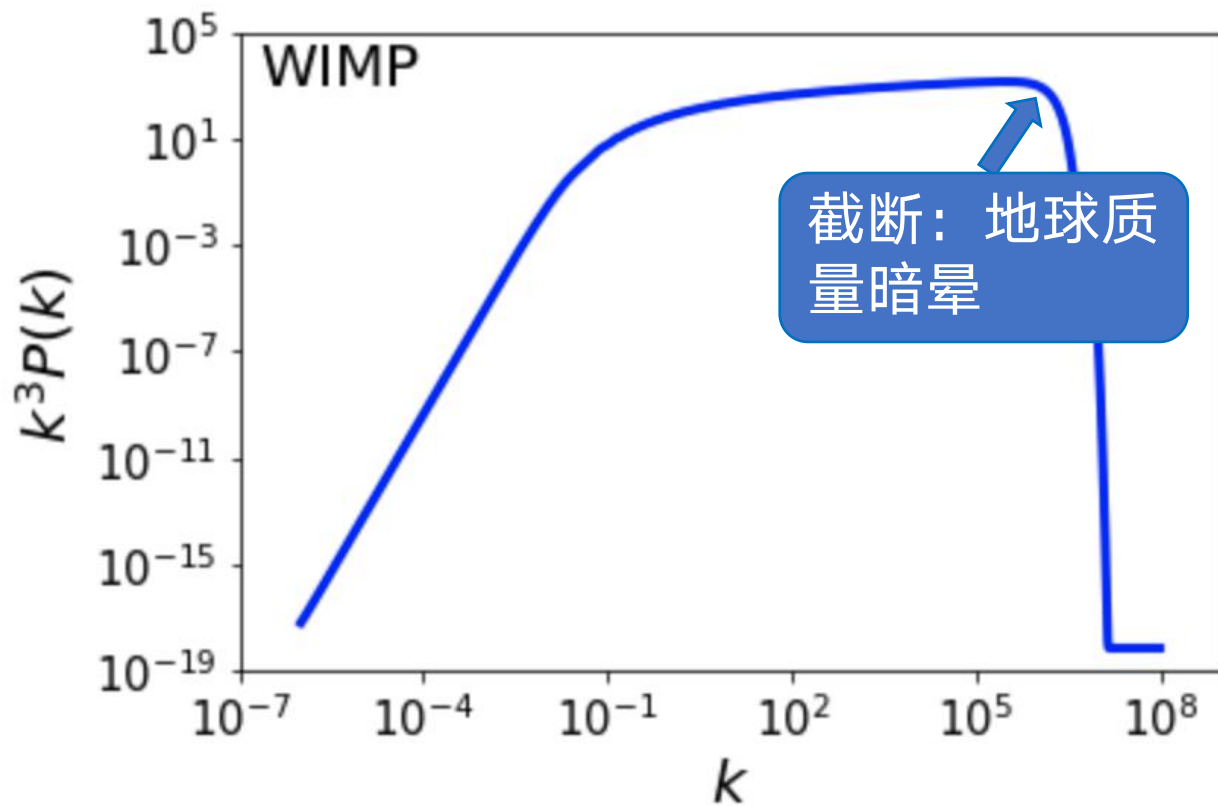
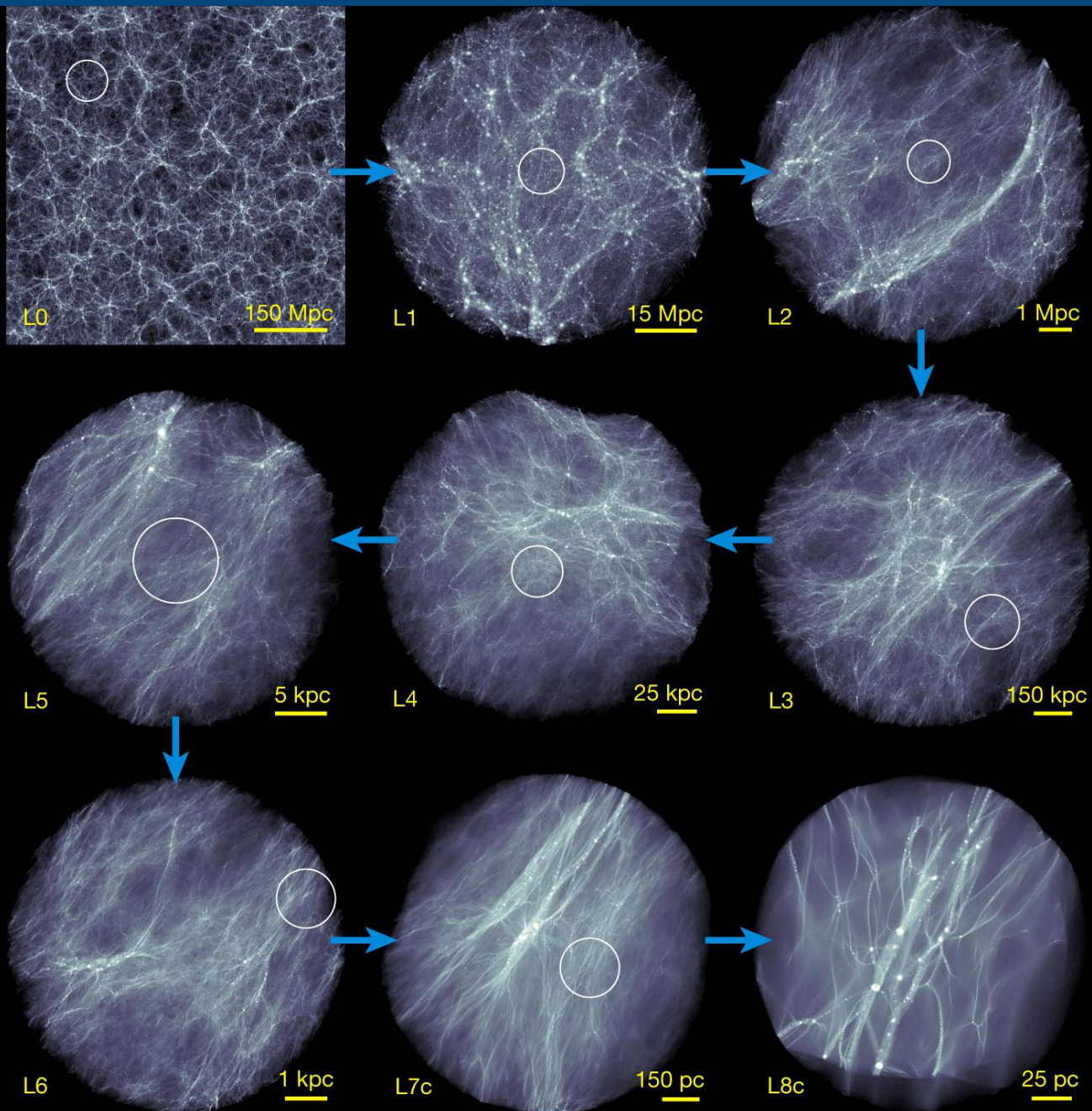
暗晕的聚集因子
concentration

暗晕的形成时间
formation time

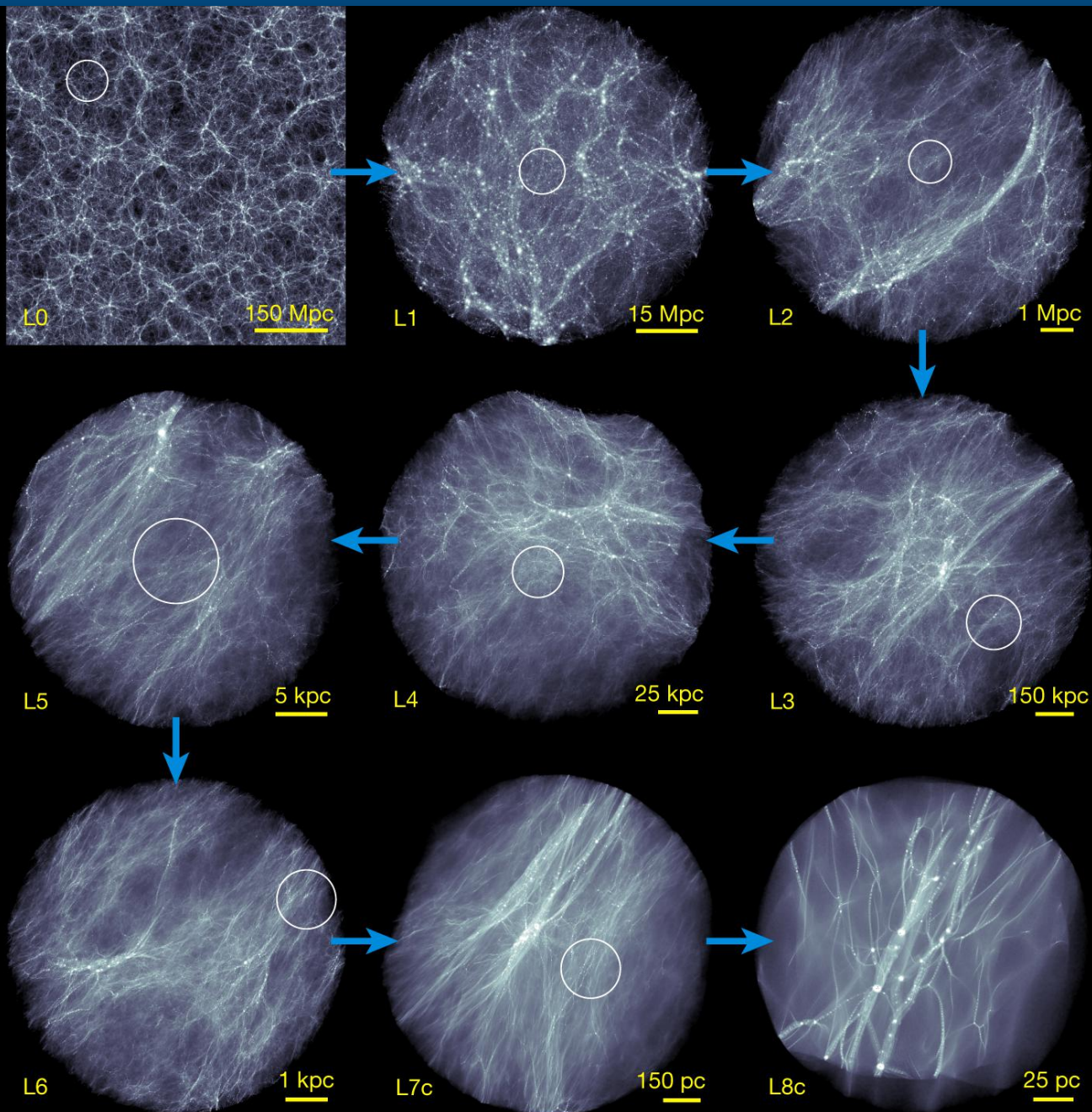
暗晕的子结构丰度
substructure

暗晕的势场
potential field

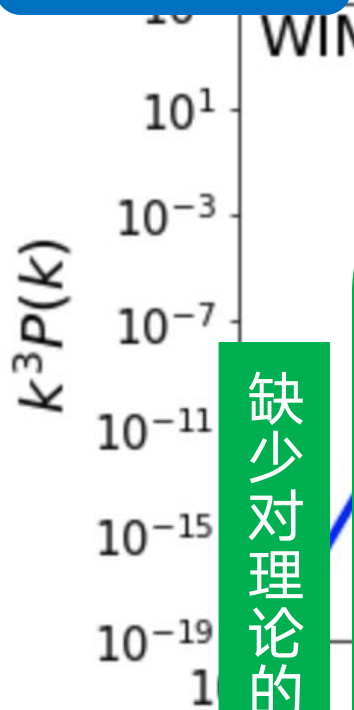
研究动机：Cosmic-Zoom模拟



研究动机：Cosmic-Zoom模拟



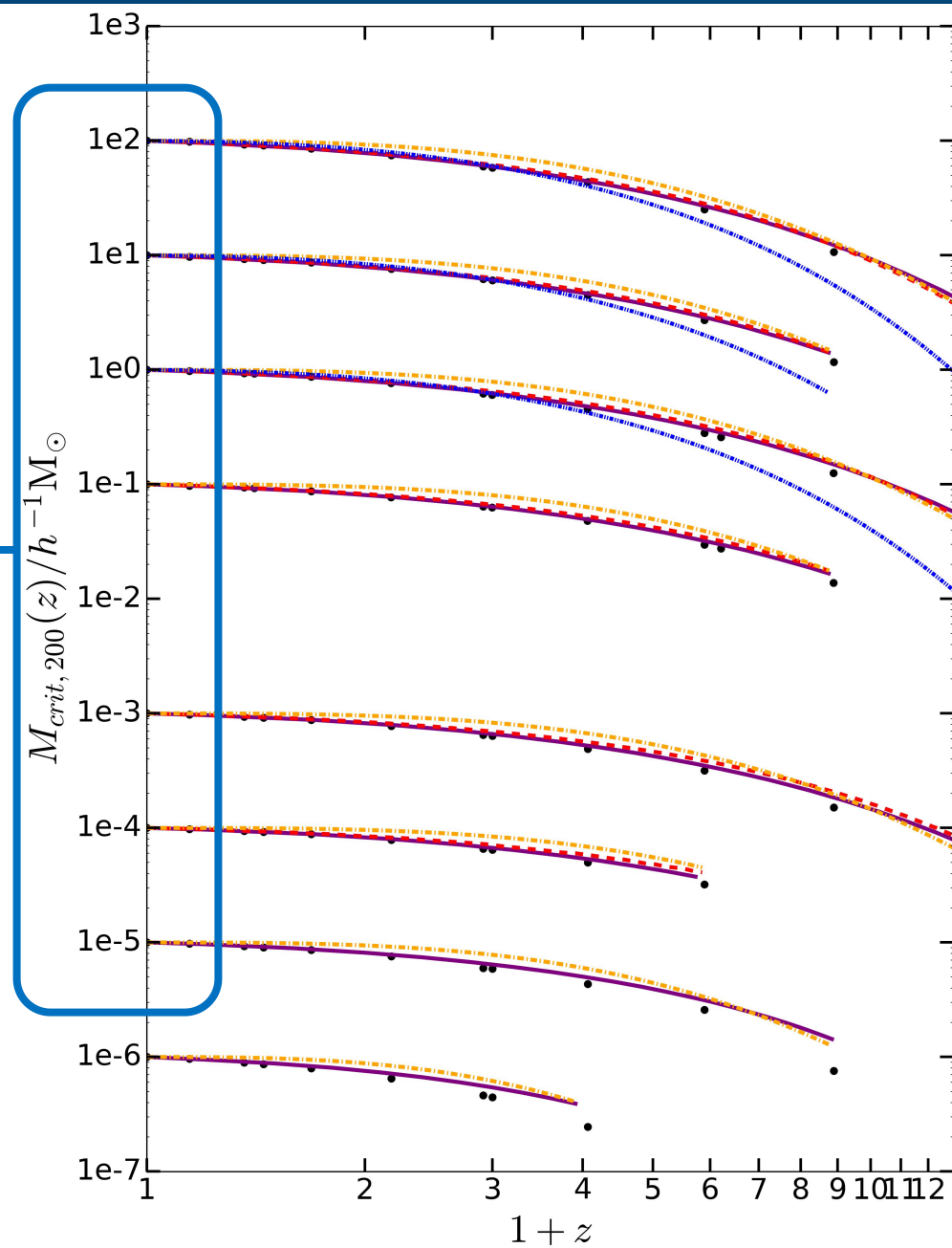
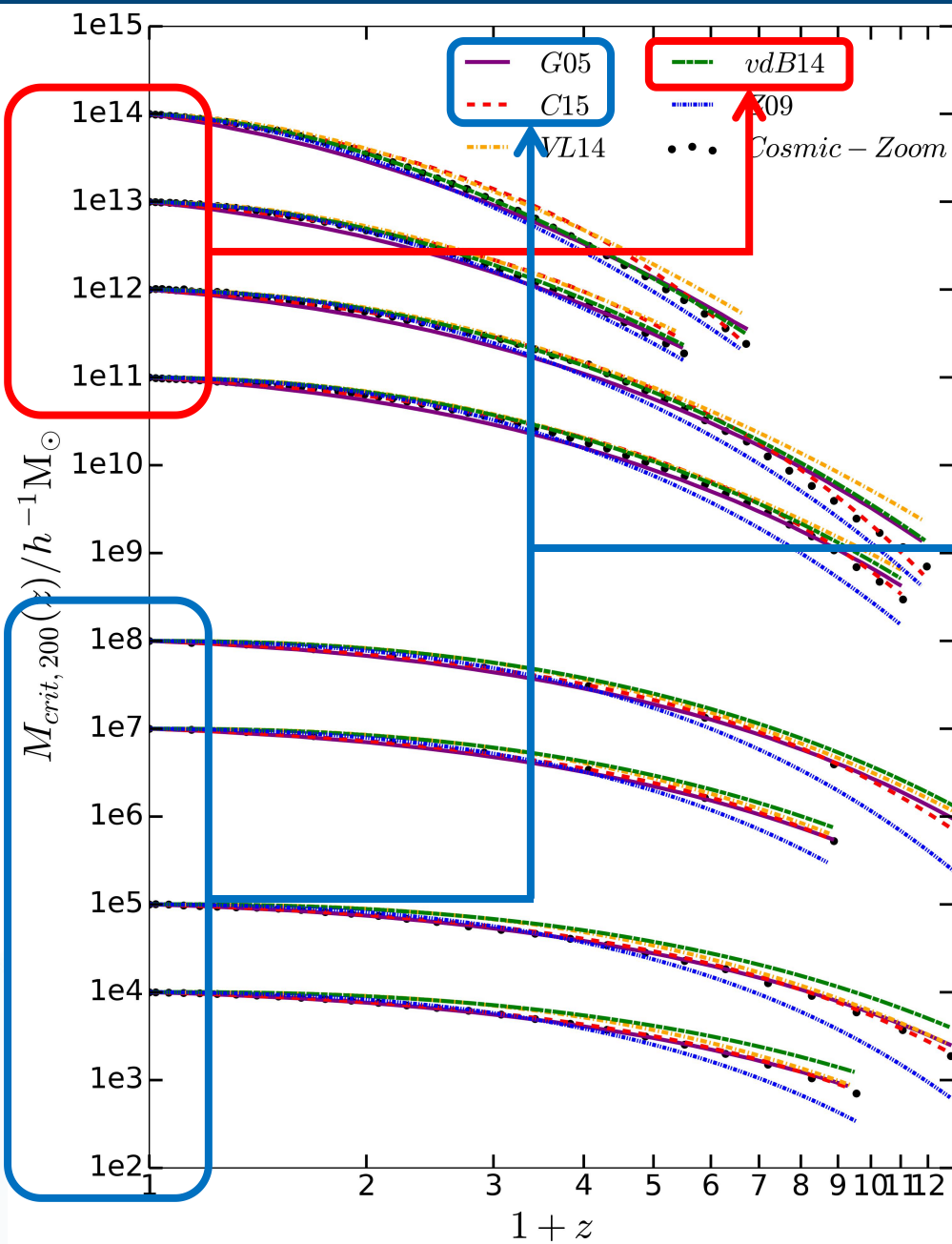
星系团尺度



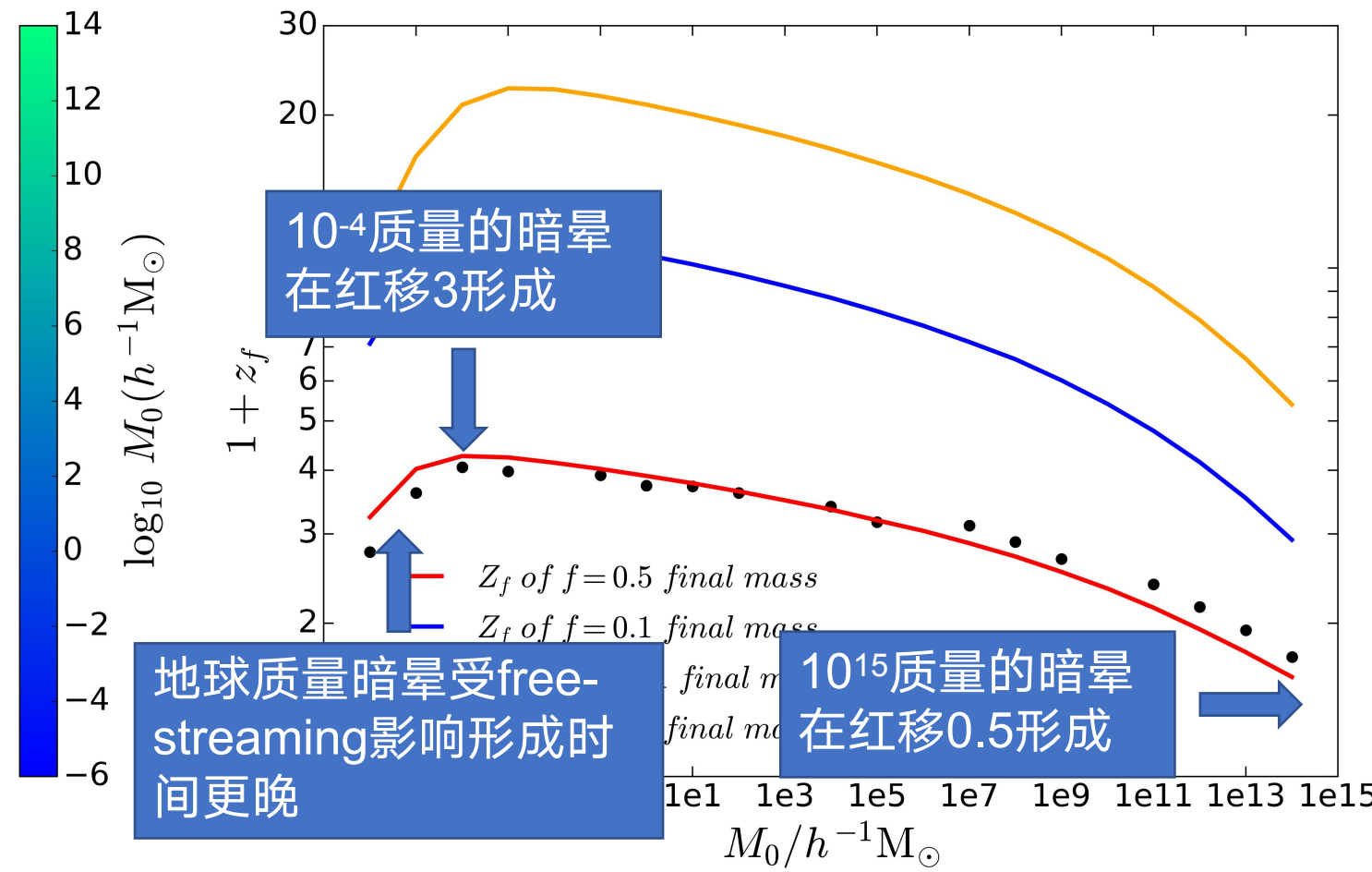
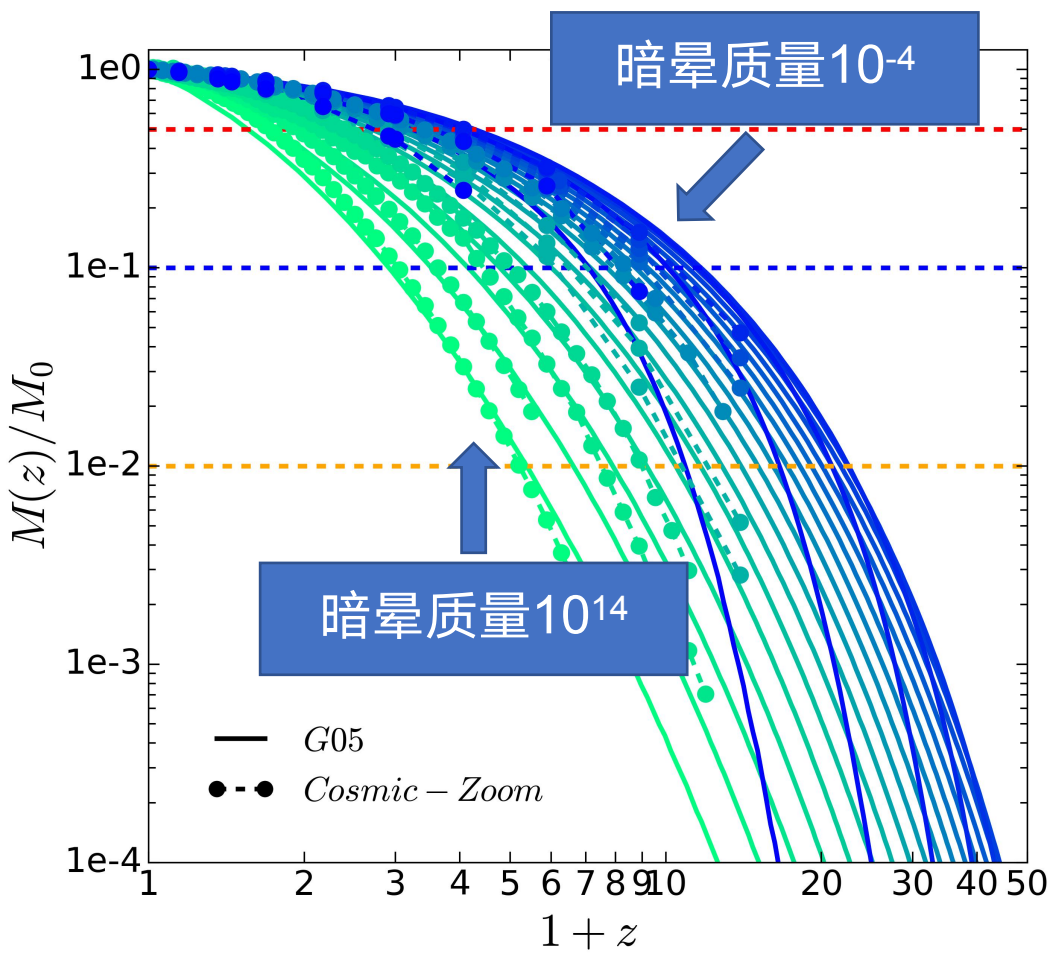
地球质量

区域	暗晕质量
L0	10^{14}
L1	10^{12}
L2	10^9
L3	10^6
L4	10^3
L5	10
L6	10^{-1}
L7c	10^{-4}
L8c	10^{-6}

研究结果：不同模型的测试结果



研究结果：不同质量暗晕的增长历史



研究结论

- 1、利用Cosmic-Zoom模拟的优势，我们研究发现由EPS理论构建的增长历史模型在模拟中基本都是适用的，这说明EPS理论依然是一个可以用来预言暗晕增长历史的理论；
- 2、在现有的增长历史模型中，拟合模型能更好的描述大质量暗晕的演化历史，而解析模型则更适用于小质量暗晕，这主要是因为拟合模型基于已有的宇宙学模型进行修正过；
- 3、由于暗晕的内部结构与它的增长历史息息相关，而在本次课题中，我们对不同的模型都进行了分析，因此之后的研究中可以基于本文的结论，选择合适的增长历史模型，对各个质量的暗晕的聚集因子、形成时间、子结构丰度、势场演化等相关性质进行预言。

- Cole S., Lacey C. G., Baugh C. M., Frenk C. S., 2000, Monthly Notices of the Royal Astronomical Society, 319, 168
- Correa C. A., Wyithe J. S. B., Schaye J., Duffy A. R., 2015, Monthly Notices of the Royal Astronomical Society, 450, 1514
- Gao L., White S. D., 2007, Monthly Notices of the Royal Astronomical Society: Letters, 377, L5
- Gao L., Springel V., White S. D., 2005a, Monthly Notices of the Royal Astronomical Society: Letters, 363, L66
- Gao L., White S. D., Jenkins A., Frenk C., Springel V., 2005b, Monthly Notices of the Royal Astronomical Society, 363, 379
- Giocoli C., Tormen G., Sheth R. K., van den Bosch F. C., 2010, Monthly Notices of the Royal Astronomical Society, 404, 502
- Jiang F., van den Bosch F. C., 2014, Monthly Notices of the Royal Astronomical Society, 440, 193
- Kauffmann G., White S. D., 1993, Monthly Notices of the Royal Astronomical Society, 261, 921
- Lacey C., Cole S., 1993, Monthly Notices of the Royal Astronomical Society, 262, 627
- Li Y., Mo H., Gao L., 2008, Monthly Notices of the Royal Astronomical Society, 389, 1419
- Lovell M. R., Frenk C. S., Eke V. R., Jenkins A., Gao L., Theuns T., 2014, Monthly Notices of the Royal Astronomical Society, 439, 300
- Ludlow A. D., Navarro J. F., Angulo R. E., Boylan-Kolchin M., Springel V., Frenk C., White S. D., 2014, Monthly Notices of the Royal Astronomical Society, 441, 378

- McBride J., Fakhouri O., Ma C.-P., 2009, *Monthly Notices of the Royal Astronomical Society*, 398, 1858
- Neistein E., Van Den Bosch F. C., Dekel A., 2006, *Monthly Notices of the Royal Astronomical Society*, 372, 933
- Parkinson H., Cole S., Helly J., 2008, *Monthly Notices of the Royal Astronomical Society*, 383, 557
- Somerville R. S., Kolatt T. S., 1999, *Monthly Notices of the Royal Astronomical Society*, 305, 1
- van den Bosch F. C., 2002, *Monthly Notices of the Royal Astronomical Society*, 331, 98
- van den Bosch F. C., Jiang F., Hearin A., Campbell D., Watson D., Padmanabhan N., 2014, *Monthly Notices of the Royal Astronomical Society*, 445, 1713
- Wang J., Bose S., Frenk C. S., Gao L., Jenkins A., Springel V., White S. D., 2020, *Nature*, 585, 39
- Wechsler R. H., Bullock J. S., Primack J. R., Kravtsov A. V., Dekel A., 2002, *The Astrophysical Journal*, 568, 52
- Zhang J., Fakhouri O., Ma C.-P., 2008, *Monthly Notices of the Royal Astronomical Society*, 389, 1521
- Zhao D., Mo H., Jing Y., Boerner G., 2003a, *Monthly Notices of the Royal Astronomical Society*, 339, 12
- Zhao D.-H., Jing Y., Mo H., Börner G., 2003b, *The Astrophysical Journal Letters*, 597, L9
- Zhao D., Jing Y., Mo H., Börner G., 2009, *The Astrophysical Journal*, 707, 354



谢谢