

Some study questions for oral exam

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The below provides some (note: not complete) potential study questions for the oral exam, organised according to the lectures.

E.1 Organisation, orientation & overview: 10 Feb

What are some different galaxy types and how do they differ? What are typical galaxy morphologies and spectral features for various types? Can you explain basic concepts such as surface brightness, galaxy luminosity function and mass-to-light ratios, including their meanings and some usages in galaxy and cosmology research?

E.2 Some galaxy and gaseous dynamics: 17 Feb

What is the isothermal sphere model for internal galaxy density distribution? How can it be related to rotation curves of galaxies? What are the so-called king models? What is the virial theorem and how can it be applied for galaxy dynamics research? What is the so-called NFW profile? How can hydrostatic equilibrium be used to infer masses of clusters of galaxies?

E.3 Disk galaxies including milky way: 24 Feb

What are the main structural components of spiral galaxies? What is the difference between the thin and thick disk? Why do inferred rotation curves of spiral galaxies suggest the presence of non-luminous matter? How can the hydrogen 21 cm spectral line be used in galaxy research? How do disk stars and stars in the halo often differ? Why do we believe that the dark matter halo must extend to much larger radii than the visible Milky Way? What are typical surface brightness profiles for spirals? What is the Tully-Fischer relation?

E.4 Ellipticals and dwarfs: 3 Mar

How do general properties differ between disk, elliptical, and dwarf galaxies (for example their colours, surface brightness, etc)? What are their typical scales? What is the fundamental plane of elliptical galaxies? Are large ellipticals believed to be rotationally flattened? What is the so-called age-metallicity degeneracy-problem? Are there any basic differences between globular star clusters and dwarf galaxies? How are detection of dwarf galaxies related to the so-called "missing satellite problem" of cosmological modeling? What are so-called "green pea" galaxies?

E.5 Active galaxies and supermassive black holes: 10 Mar

What are some basic differences between "normal" and "active" galaxy spectra? What different types of active galaxies are there? How do they differ? What is the consensus model for active galaxies? What is the primary reason the Milky Way of today is not classified as an active galaxy? Can you qualitatively describe the process behind accretion upon a supermassive black hole? What are BLR clouds? How can we explain that quasars seem to be much more common in the past than today? What is the role of outflows from AGNs in controlling galaxy formation? What type of outflows do AGNs have? What is the so-called "m-sigma" relation?

E.6 Galaxy clusters: 17 Mar

What are some differences between groups and clusters of galaxies? What are their typical scales? Are there any issues with obtaining clear definitions for even larger formations, such as superclusters? Can you describe three key ways of inferring masses of galaxy clusters? What do such mass measurements tell us about the dominant matter components of galaxy clusters? What are cooling flows? What is the Butcher-Oemler effect? What is the Sunyaev-Zeldovich effect?

E.7 Homogeneous world models: 24 Mar

What are some fundamental observations that any model for the evolution of the Universe should explain? Why does it work to derive some of the basic equations of the expansion of the Universe also within a Newtonian framework? What does the Friedman-Lemaître equation describe? What are the different equation of states for the components included in the Friedman-Lemaître equation? What are the individual roles of matter, radiation, and dark energy components for the evolution of the Universe, in the past, today, and in the future? What is the standard Λ CDM model? What are some support and issues with this standard model for the Universe? Can you describe the concepts of big bang nucleosynthesis, recombination, and inflation?

E.8 Structure growth, evidence for Lambda: 31 Mar

What mainly controls if density perturbations grows over time or not? What is the main components of the hierarchical model of structure formation? Why is structure formation only believed to start at the time of photon-baryon decoupling? What is the main difference between cold and hot dm, and how does it affect structure formation and growth? What is the substructure-problem? What is the cusp-core problem? Can you describe the main observational evidence for "dark energy"? How can different observations be combined to obtain better constraints on cosmological parameters?

E.9 Early Universe, galaxy formation and evolution: 21 Apr

What is a key difference between formation of stars in present-day and primordial Universe? How does this affect the properties of the stars? How are the first galaxies believed to be formed? What is cosmic reionization? What is the so-called Ly α forest? What is a starburst galaxy? Can you describe what is meant by the problem of the origin of SMBHs in the Universe? And why do we believe that such SMBHs were present already in the early Universe? Can you describe some of the main components in the present-day favoured formation scenario of disk and elliptical galaxies? Why is it believed that radiative cooling is extremely important for understanding galaxy formation and evolution, and what is the so-called "overcooling" problem? What is the difference between a minor and major merger? What are some types of "feedback" processes that are believed to be crucial for formation and evolution of galaxies?