



# Review Exam 3



# Key questions

- What is a black hole's event horizon?
- What is a black hole's Schwarzschild radius?
- What is a black hole's singularity?
- How do they change with mass?
- A probe/human falls into a black hole. Describe what happens to it.
- What is a tidal force?
- How can we detect a black hole? What about a non-accreting black hole entering our Solar System?



# Key questions

- What is Hawking radiation?
- What's in the center of our Galaxy?
- How do we know?
- What is more likely to enter our Solar System, a star or a compact object (i.e. black hole, white dwarf, or neutron star)?
- What are possible effects of a black hole entering the Solar System?
- What are the effects of a black hole colliding with the Earth?



# Key questions

- What are micro-black holes?
- What are stranglets?
- Why don't we think that the LHC will make them? Even if they do, why is it not expected to be a problem?
- What is the Milky Way?
- What type of galaxy is it?
- Where is the Sun in the Milky Way?
- What are globular clusters and what role did they have in understanding the Milky Way?



# Key questions

- What are the four Copernican revolutions? Hint, the 4<sup>th</sup> is finding ET (We are not alone in the Universe.)
- What are the four components or structures of the Milky Way? In which structure is the Sun located?
- How do we know that the Milky Way has spiral arms?
- How do stars rotate in the disk of the Milky Way?
- If you have three stars at different locations in the disk, will they travel different distances in the same time?



# Key questions

- What is a rotation curve of the Milky Way? And why is it flat? What does that mean? How do we explain it?
- What did the “spiral nebulae” turn out to be?
- What are the three types of galaxies?
- What is a spiral arm made out of?
- What might happen if the Solar System enters one?
- What does the color of a galaxy tell us about its stellar population?



# Key questions

- Are galaxies usually alone? What is the local group?
- What happens when two galaxies collide?
- What might happen when Milkomeda is formed?  
What might happen to the Solar System? The Milky Way? Andromeda?
- What is Olber's paradox?
- How are galaxies moving? What does it mean?  
What is Hubble's Law?
- Is Brooklyn expanding?
- What are some misconceptions of the Big Bang?
- What was the Universe like early on?



# Key questions

- Where was the Big Bang?
- What is the CMB? Where does it come from?
- What caused the small perturbations in the CMB? Why do I call them the seeds of galaxies?
- What makes up a proton and neutron?
- What is anti-matter? Why are we matter?
- What is Big Bang Nucleosynthesis?
- What was the Era of Recombination?
- When were the first stars born?
- What are the three big pieces of evidence of the Big Bang?





# Key questions

- What is the most likely fate of the Universe?
- What is a closed, open, or flat Universe?
- We are likely flat, but don't weigh enough, so what do we invoke?
- Why does the fate of the Universe depend on its properties?
- What is the Big Rip?
- What is the Big Crunch?
- What is the Big Chill?



# Key questions

- If the Universe keeps expanding, what happens to our view of other galaxies?
- What is left after 100 trillion years?
- How big does our supermassive black hole get? Does it eat everything?
- What is proton decay?
- What happens to all black holes with enough time?
- What is the idea of branes creating another Big Bang?



# Key questions

- What is a quasar?
- How were they discovered?
- What powers a quasar?
- Are there any nearby quasars right now?
- What if Andromeda's BH feeds?
- What happens during the creation of Milkomeda? Any quasars-like properties?
- We can estimate the number of intelligent life in the Universe how?
- We can estimate the number of intelligent life in the Galaxy how?



# Key questions

- What does the Drake Equation tell us?
- What is the Habitable Zone?
- Does any evidence of life exist in the Solar System, except for Earth?
- Why don't we know about life on the early Earth?
- What are Extremophiles?
- Why is life on Earth ubiquitous?
- What is Panspermia?
- Why is alien bacteria or virus unlikely to be seriously dangerous to humans?



# Key questions

- What are some problems with interstellar travel?
- What is an optimistic/pessimistic time estimate for an advanced civilization to colonize the Galaxy?
- What is the Fermi Paradox?
- What is arguably the simplest way for a civilization to explore the Universe? Hint, armchair explorers.