

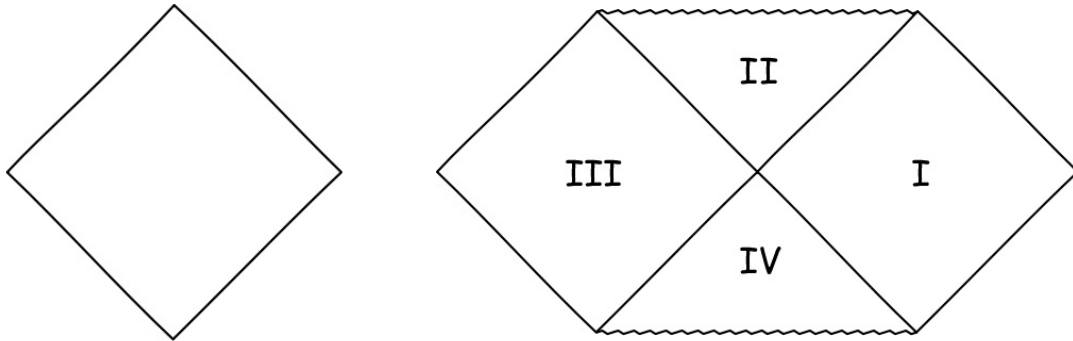
Homework Assignment 8

25 Science, Philosophy, and the Big Questions

due 9 March 2012

For submission

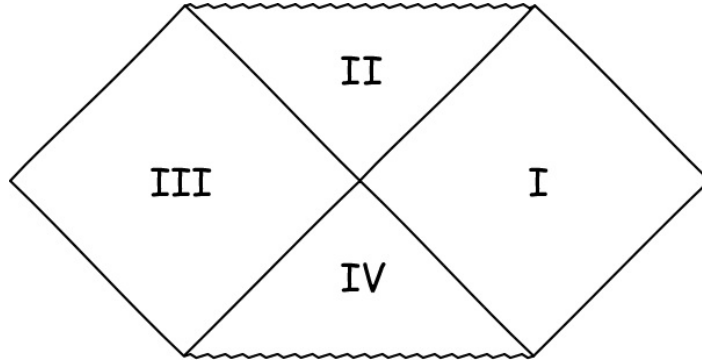
1. Why do black holes result from gravitation and not, say, from electric or magnetic attractions?
2. What sorts of objects in our universe are candidates for collapse into a black hole?
3. In the context of a black hole, what are (a) the singularity; (b) the event horizon; (c) tidal forces?
4. Here are conformal diagrams of a Minkowski spacetime and fully extended, Schwarzschild black hole.



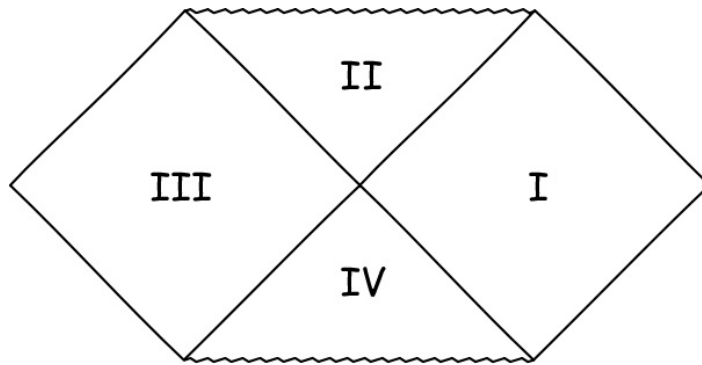
Using both words and the appropriate symbols, label:

- (a) future timelike infinity
- (b) past timelike infinity
- (c) future lightlike infinity
- (d) past lightlike infinity
- (e) spacelike infinity
- (f) future singularity
- (g) past singularity
- (h) event horizon

5. (a) Use the conformal diagram below to show that a traveler cannot pass from the world of region III to that of region I; and that light signals also cannot pass from region III to I.



- (b) Use the conformal diagram below to show that travelers from the worlds of regions I and III can meet.



For discussion in the recitation

Some questions about black holes:

- A. If black holes let no light escape, how is it possible for us identify candidate black holes among what our telescopes see in the sky?
- B. (a) What prevents the gravitational collapse of planets? (b) What prevents the gravitational collapse of stars?
- C. What are three differences between a Newtonian and a relativistic black hole?
- D. Minkowski spacetimes are well behaved in so far as there are no inaccessible regions. Illustrate this by picking any event in the conformal diagram of the Minkowski spacetime and showing that it can always be reached by some space traveller, who proceeds from past timelike infinity at less than the speed of light.
- E. Use a conformal diagram of a black hole to show that an outside observer can only see a portion of the trajectory of a traveler who falls into the black hole.

F. We have learned repeatedly to be suspicious of things that are supposed to exist but whose properties are so set up as to make our detecting them impossible. Is the world of region III such a thing? We, in region I, cannot visit it or receive signals from it; and no one from region III can visit or signal us in region I.