

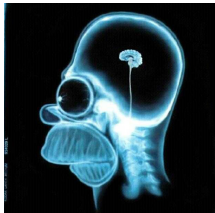
## General Astronomy II, Spring 2019

## PROBLEM SET 2



**Deadline:** 11PM WEDNESDAY, APRIL 3, 2019

**Submission:** iLMS PLATFORM



Early one morning, you bumped into Homer Simpson in a coffee shop. Homer had his own ideas of how and why everything is in the universe and insisted that his ideas were right. But you know that a lot of his thoughts may not be correct, not any better than what shows in an X-ray image of his brain.

After hearing what Homer had to say, you decided to convince him with what you have learned in the class. You must let Homer know which part of his arguments went wrong.

1. **Galaxy rotation and dark matter (40%).** Many disk galaxies show rotation motions faster than the allowed speed given by the gravitational force of all the visible mass.

**Homer:** I know stars in disk galaxies rotate about their center, where a supermassive black hole sits (Fig. 1). These stars rotate about this supermassive black hole. I do not like something invisible. They call it dark matter. It is such a crazy idea!

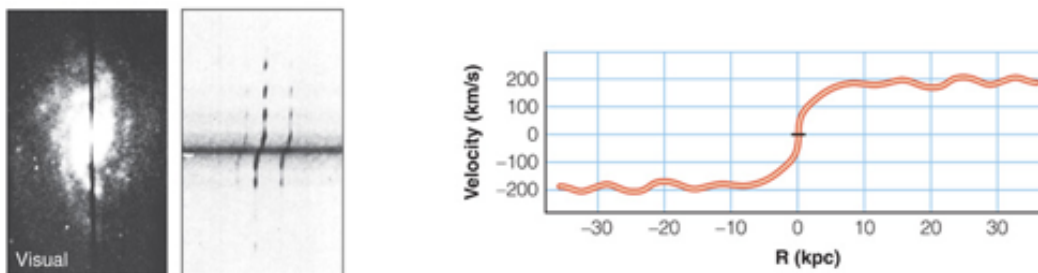


Figure 1: Example rotation curve of a disk galaxy.

- (a) (20%) Do you agree with Homer's idea about galaxy rotation? If not, tell him what is the expected outcome of his idea?
  - (b) (20%) Can you tell him why astronomers think dark matter is needed to explain the galaxy rotation?
2. **Galaxy Formation Scenarios (40%+20%).** Astronomers propose two possible scenarios to form galaxies, top-down model and bottom-up hypothesis.

**Homer:** I have heard about stars contain different amount of metals. The world was created in seven days together with these metals. Magnetic fields then gather metals together in some regions. Stars born in those regions have more metals in them.

- (a) (10%) Do you agree with Homer's idea about how metals come about? If not, tell him what is the expected outcome of his idea?
- (b) (10%) Can you tell Homer how astronomers use metals to tell the relative birth time of stars or star clusters?
- (c) (20%) Can you tell Homer how do astronomers come up with two competing hypothesis for galaxy formation?
- (d) (bonus 20%) How do we know the age of star clusters? (Please read Section 12-3)