

1 Introduction

For this assignment of cosmology debates, I plan to organize debates over important scientific controversies in the historical development of our worldview throughout the last 2 1/2 Millennia.

To this end, I have identified 5 outstanding and decisive topics, 3 or 4 historical ones and 2 or 3 of current interest. The planning is to have the debate on the last friday lecture of the course, January 17. This in order to allow you sufficient preparation time.

As with the Cosmology Awareness Poll you will get organized into 10 groups, each of 8 (some 9) people. You will be given a particular topic and view, which will be the view opposed to one of the other groups. Each group is expected to prepare themselves on the arguments that are relevant and related to the topic. On January 17, you will then be set opposite to the members of the other group, and asked to start the discussion on the basis of these arguments.

The intention is to let you appreciate that ideas are not established and/or accepted immediately. Not even proven. There are always arguments in favour and counter arguments. Thus, no matter whether you have to defend a view that at hindsight turned out to be wrong, there is/was a substantial body of evidence/argument in favour. It might even at the time have been more convincing ...

To be able to defend your cause well, you need to thoroughly prepare yourself in the literature and not only identify the argument in favour of your view, but also identify the possible counter arguments. Of course, you will not have insight into the arguments forwarded by your opponents. In historic debates you are expected to use arguments and evidence available at the time (you obviously can smash the geocentric view based on the probes that have visited the planets in our solar system during the 20th and 21st century, but that is hardly interesting for the sake of learning about scientific argument).

The debates themselves will consist of four parts. First each party has to present their case in a short presentation. Subsequently, you will have 5-10 minutes of real debate, trying to address and argue against the views forwarded by the opposite party. This is followed by a final plea by each of the groups. Finally, the public (ie. the people not part of any of the two groups) vote on whom has won the debate.

2 Organization

To explore this further, we will form groups of 8 (or 9) students. Each group will be

1. assigned one of the debating topics
2. assigned one of the two opposing views
3. distribute task in the group. Either all or at least several of the members investigate the literature on the issues and (historical, scientific) background of the topic and the various viewpoints.
- 4. prepare a report/document - of 5-8 pages - in which the arguments are clearly set out and discussed, including literature references.
5. one of the members will take charge of presenting the case at the beginning of the debate. If necessary, pptx/pdf slides are allowed, as well as a written text/report.
6. one of the members will be responsible for the final plea.
7. all members are expected to participate in the debate.

3 Cosmological Topics of Debate

The five suggested topics of cosmological debate are the following:

1. **Ptolemaeus versus Copernicus & Galilei.** This concerns the debate between the old geocentric view, most extensively described by Ptolemaeus in his book the *Almagest*, and the "new" heliocentric view of Copernicus. This debate was convincingly won and described in the seminal book of Galilei, the *Dialogues between Worldviews*. However, originally the case was far less straightforward as you may think: the epicyclic model of the ancient Greeks and Romans was very sophisticated and surprisingly accurate. Up to you to defend or contest ! One group will defend the Ptolemaic view, the other the heliocentric view.
2. **the Great Debate: Shapley versus Curtis.** In the beginning of the 20th century, in 1920, a major historic debate was organized on the issue of whether the nebulae were external galaxies like our own Milky Way or whether they were genuine galaxies by themselves. What was at stake is nothing less than the size and scale of our Cosmos. Harlow Shapley argued in favour of the Milky Way being the entirety of the Universe. Heber Curtis held the point of view that nebulae such as the Andromeda nebula and other spiral nebulae were Island Universes (a term coined by the philosopher Kant in the 18th century). The issue got only solved in 1925 by Hubble determining the distance to the Andromeda galaxy.

3. **Steady State Universe versus Big Bang Universe.** For a long time, and in particular in the 1940s and 1950s, there was large group of cosmologist who refused to accept the view of a Big Bang Universe. This included cosmologist of high reputation such as Fred Hoyle and Hermann Bondi. Only by the discovery of the microwave background radiation in 1965, steady state was shown not to work. In this debate one group should defend steady state, the other the Big Bang. But using arguments and finding from before 1965 !
4. **Dark Matter versus Modified Gravity.** While most cosmologists agree that most of the mass in the Universe is that in the form of dark matter, no one has ever been able to find it and identify it. Therefore, there is a (small, but increasing) group of physicists and cosmologists that propose that the force of gravity is not correctly described by Einstein's theory of General Relativity. Instead, they argue gravity on at least some distances works differently, and that the measurements suggesting the presence of dark matter (and dark energy) are the result of the use of the wrong force law. In this debate one group has to defend the standard view implying the reality of dark matter, the other the opposite view that another force law is needed (recall recent publicity around Eric Verlinde).
5. **Multiverse vs. Universe.** A range of physicists and cosmologists have pointed out that we live in a universe that is beset by a few remarkable coincidences that are hard to explain. Why does the Universe have the dominant energy forms of dark matter and dark energy, why do we live in a universe in which dark energy took over as dominant substance at the epoch structure (and thus humans) matured, why are the values of natural constants such that we (life) was able to emerge, etc. One interpretation says that this is simply a matter of random coincidence: besides our own Universe there would be a multitude of other Universes, each of which randomly samples values for the laws of nature and natural constants. Within the context of string theories for quantum gravity and inflationary universes this might even be expected. Other cosmologists and physicists argue against this on the principle that this does not explain anything profoundly and that they prefer to understand why nature is the way it is.

4 Preparations

While preparing your debate issue, you may consult me on the relevance of the material that you would like to use in the argumentation. You are most welcome to do so.

5 Conclusion

I am looking forward to a set of interesting (and entertaining) Cosmological Debates ... and wish you all much success in preparing, and of course in winning the debates,

with best wishes, Rien