

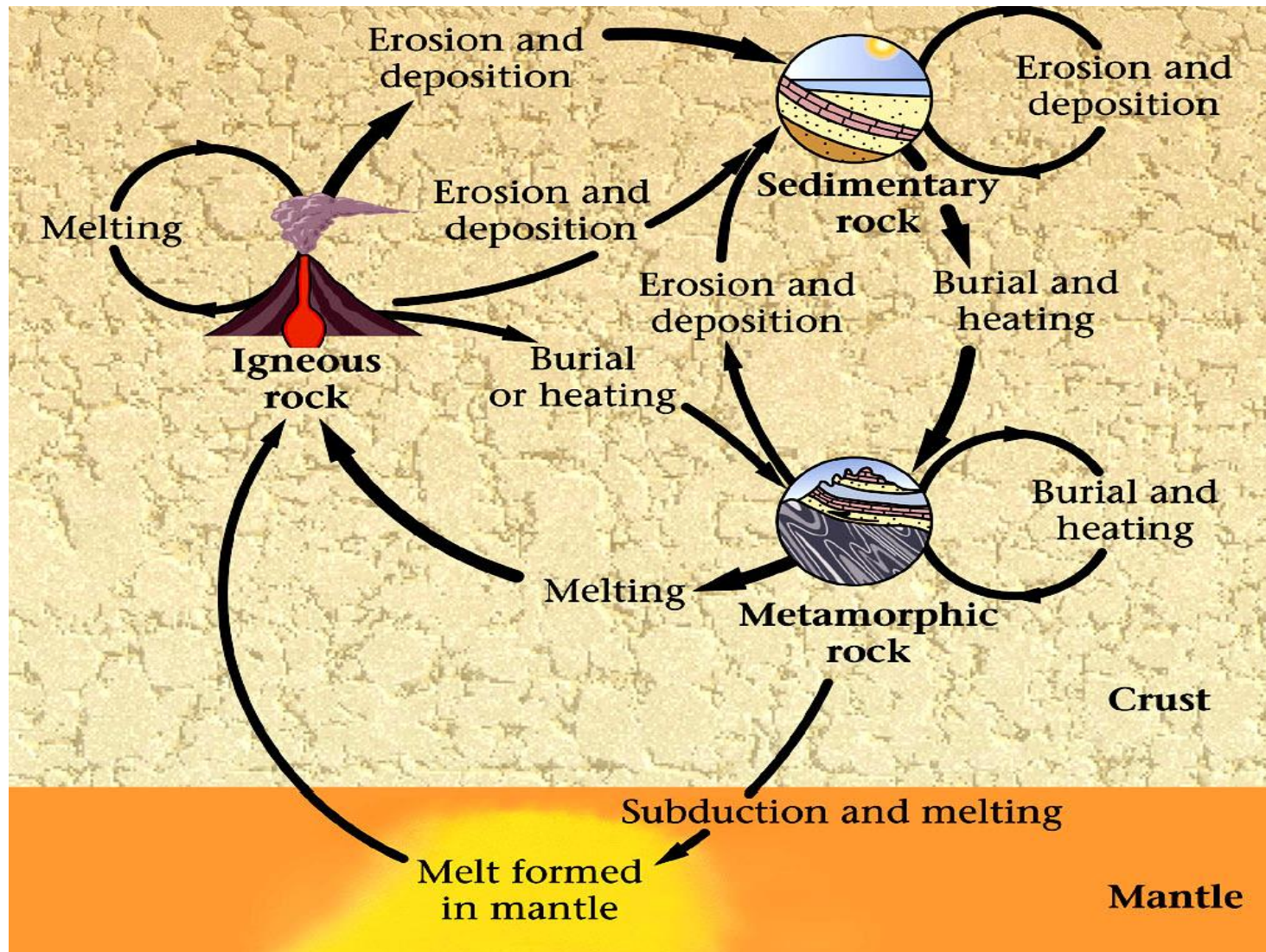
Understanding Planet Earth

Introduction to Geology and Geological Processes

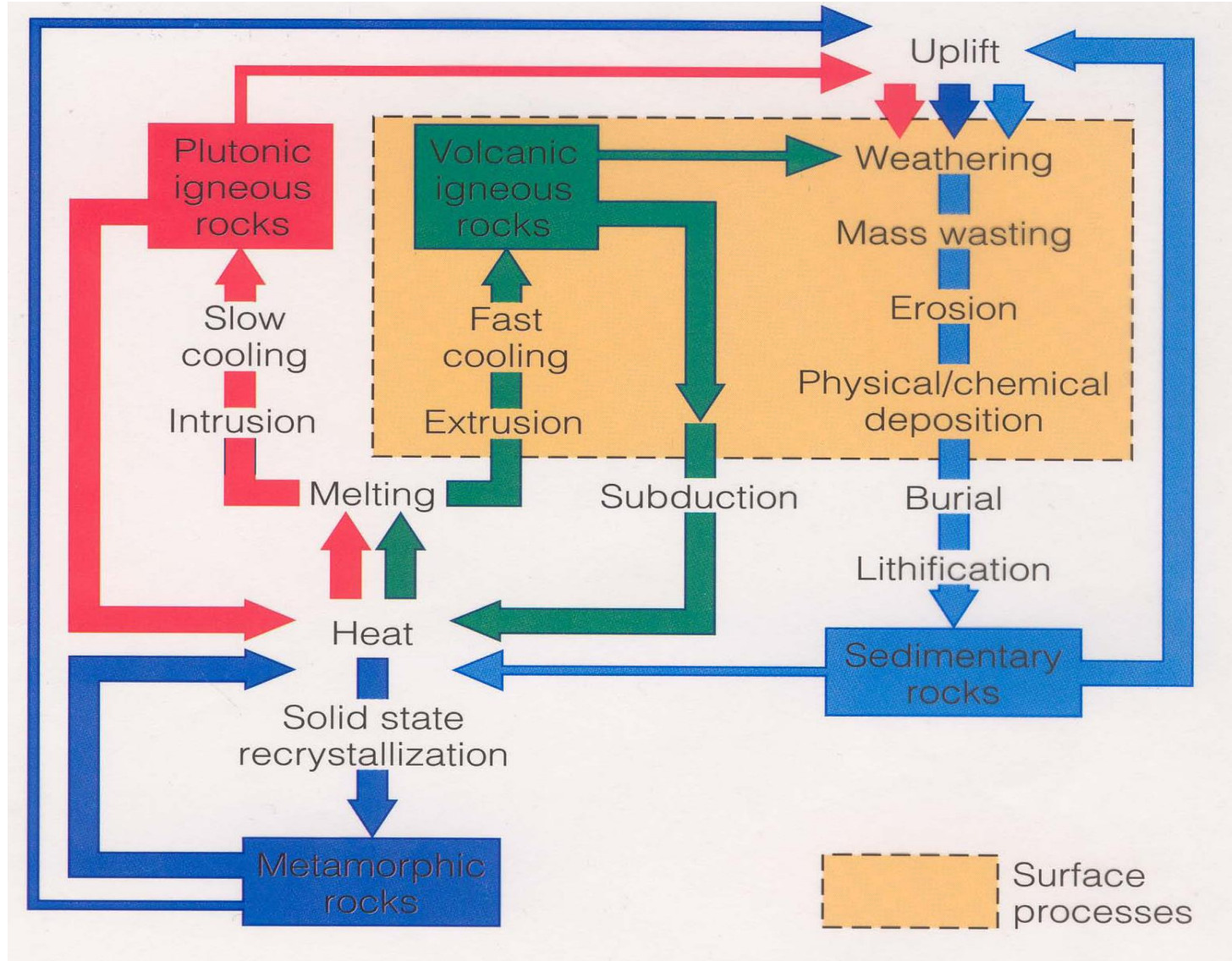
Professor: [Olivia Jensen](#) ([course e-mail](#) | [web service](#) | [short bio](#))



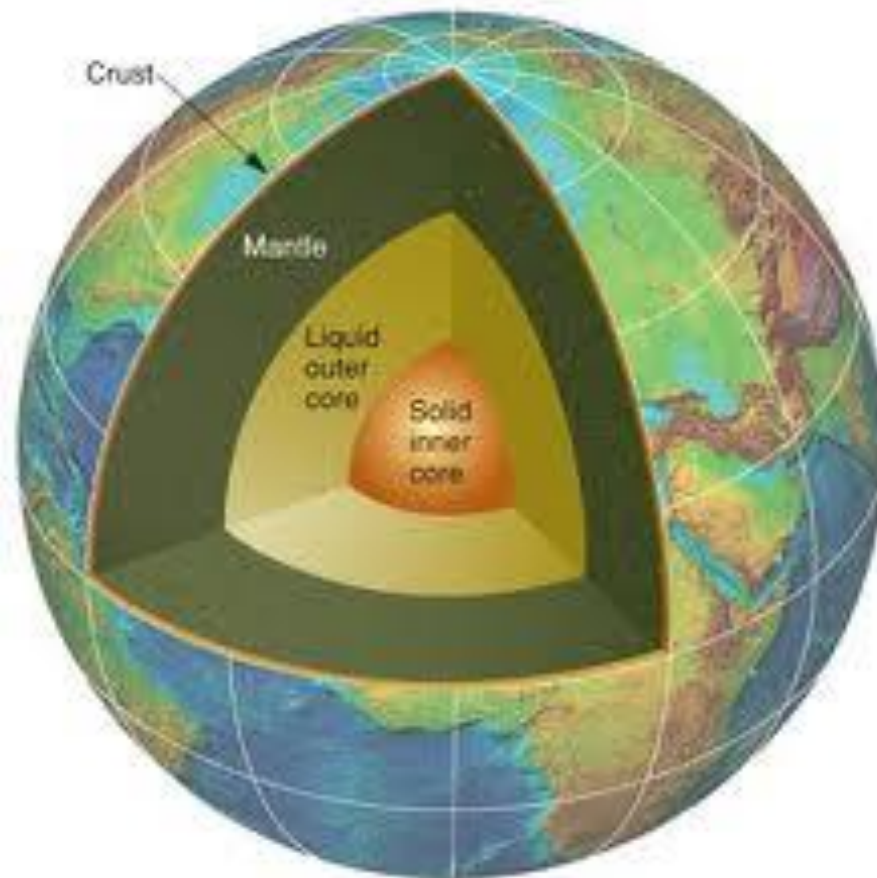
Earth's story is in its rocks

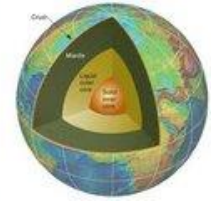


The Rock Cycle

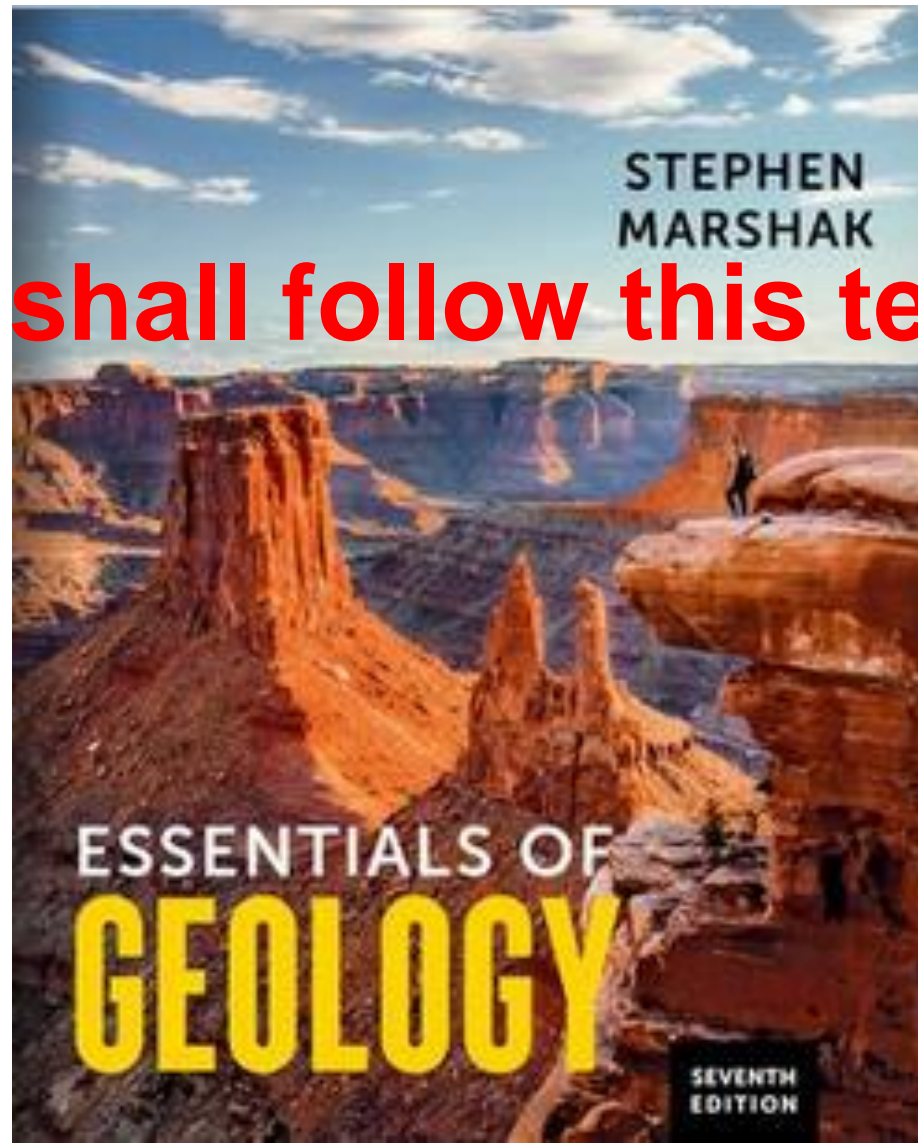


Most of our Earth is hidden from our direct view



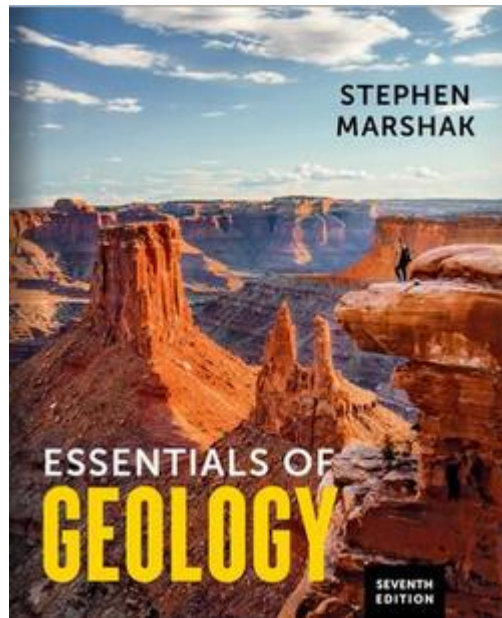


I shall follow this text



To purchase the current Edition 7 of the Text

The textbook (paperback) should be available at the McGill Bookstore
([680 Sherbrooke Street West](#))



Essentials of Geology (Seventh Edition) by Stephen Marshak

- **Publisher:** W. W. Norton & Company
- **Print:** ISBN 9780393882728, 0393882721
- **eBook:** ISBN-13: 978-0393883015

Look to the Course Syllabus for more direct links to purchase the textbook in hard copy or in digital version. The textbook is not required!



How the course will be lectured

- This course will be presented in-person or exceptionally online via pre recorded PowerPoint lectures or substituted ZOOM sessions on Tuesdays and Thursdays at 16h30 when/if required.
- You are asked to preview the online materials (PowerPoint, Video or PDF lectures) before attending the in-person sessions which are held during the scheduled course times. Lectures should be recorded.
- The PowerPoint lectures will follow a highly edited version of Norton's (the textbook's) lecture slide set that closely corresponds to the textbook. They will form the content and style of the lectures.



Planet Earth



Photo by NASA Apollo 17 crew, December 7, 1972



When did Earth form?

Religious doctrine! Euro-Christian?



John Lightfoot (1602 –1675) was an English churchman, rabbinical scholar, Vice-Chancellor of the University of Cambridge and Master of St. Catharines College

3929BCE



James Ussher (1581–1656) was Church of Ireland Archbishop of Armagh and Primate of all Ireland between 1625–1656

26 October 4004 BCE at 9AM.



When did Earth form?

Religious doctrine! Other?



Muslims do not believe that the Earth is 6,000 years old but Islam does not specify how long it has been since the creation of the Earth. Age of Earth is left ambiguous – to be determined by science!

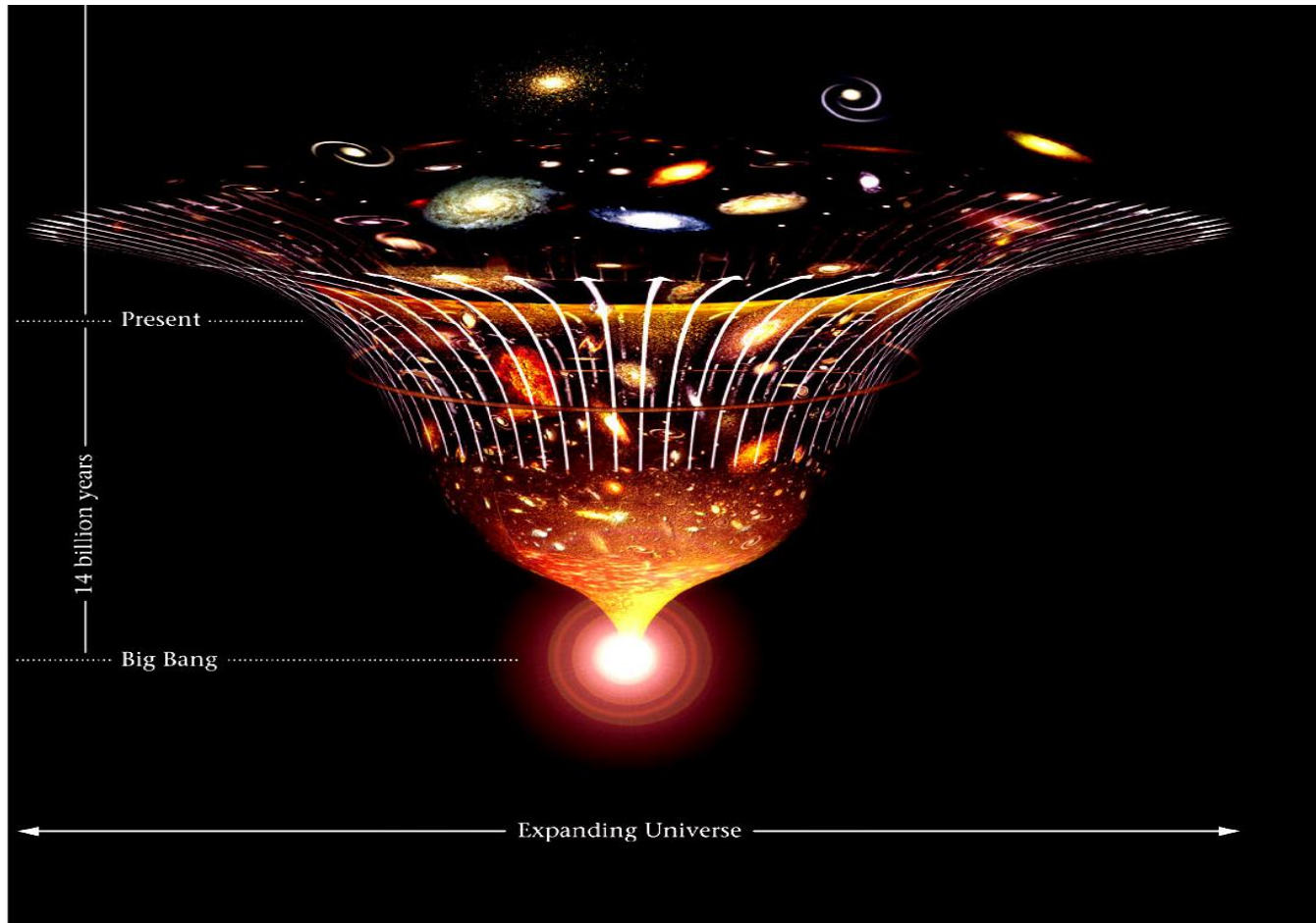


Earth came into being with the god Brahma; the Universe is 155.5 trillion years old. The age of the Earth was calculated by Indian scholars in the 5th century CE to be 4.3 billion years!

Other creation stories.



Current cosmological models!



The “Big Bang” was originally proposed by Georges LeMaître in 1927. He was a physicist and priest in the Jesuit order!



Supporting evidence for an Old Universe

- Looking into distance is to look into the past: the speed of light is a constant through the emptiness of space.

$$c = 299\,792\,458\text{ m/s}$$

- It takes light about 8 minutes to travel from the Sun (150 million km distant) to Earth. We see the Sun 8 minutes ago.
- When we look to very distant galaxies of stars, we see their past. When we look to the most distant galaxies and objects in the Universe, we see the most distant (observable) past.
- That most distant past is now best estimated to be **13.798 billion years** ago. Caveat: still, as always, under debate!



Supporting evidence for an Expanding Universe

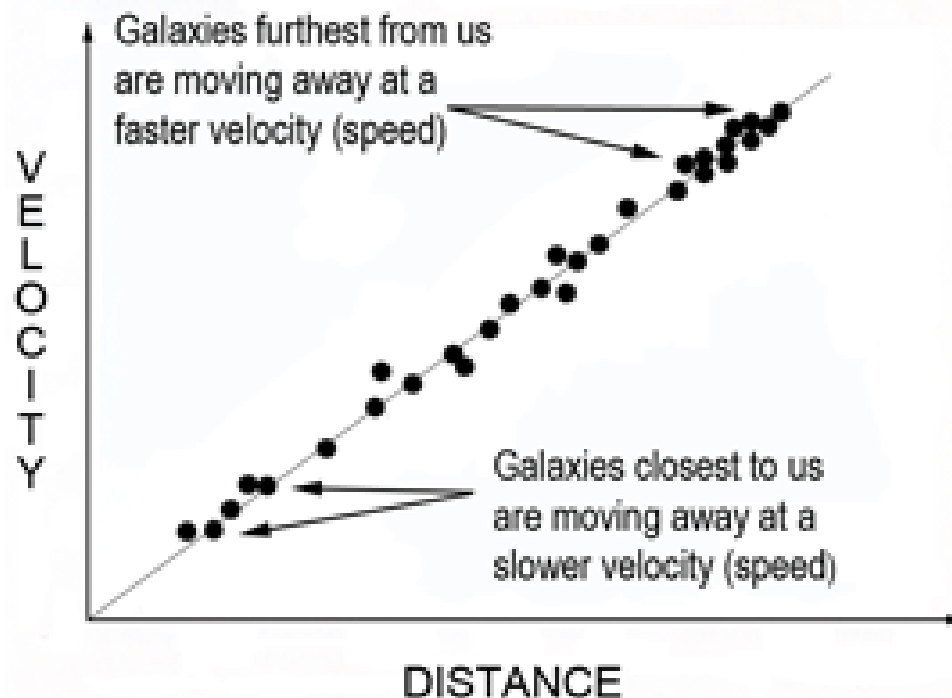
- When we measure the speed of the distant galaxies, we find that they are retreating from us at a speed that is closely proportional to their distance. The most distant we can see are retreating from us at almost the speed of light.
- This makes sense if all the galaxies started their retreat from us and us from each of them 13.798 billion years ago. That is, all these pieces of the Universe would seem to have been in one place, *right here* or we, *right there*, 13.798 billion years ago.



Supporting evidence for an Expanding Universe

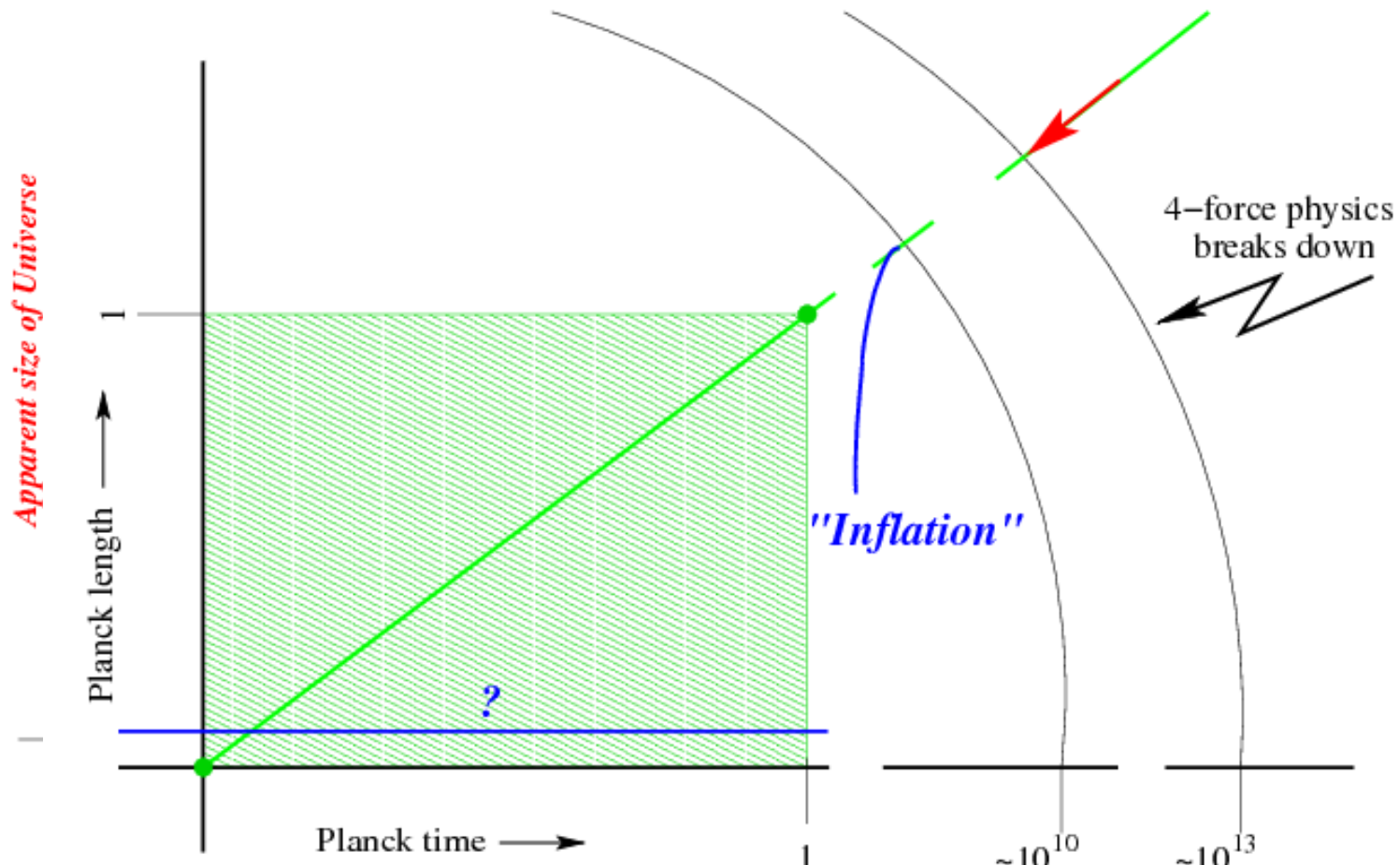
HUBBLE'S LAW

$$\text{VELOCITY} = \text{HUBBLE CONSTANT} \times \text{DISTANCE}$$



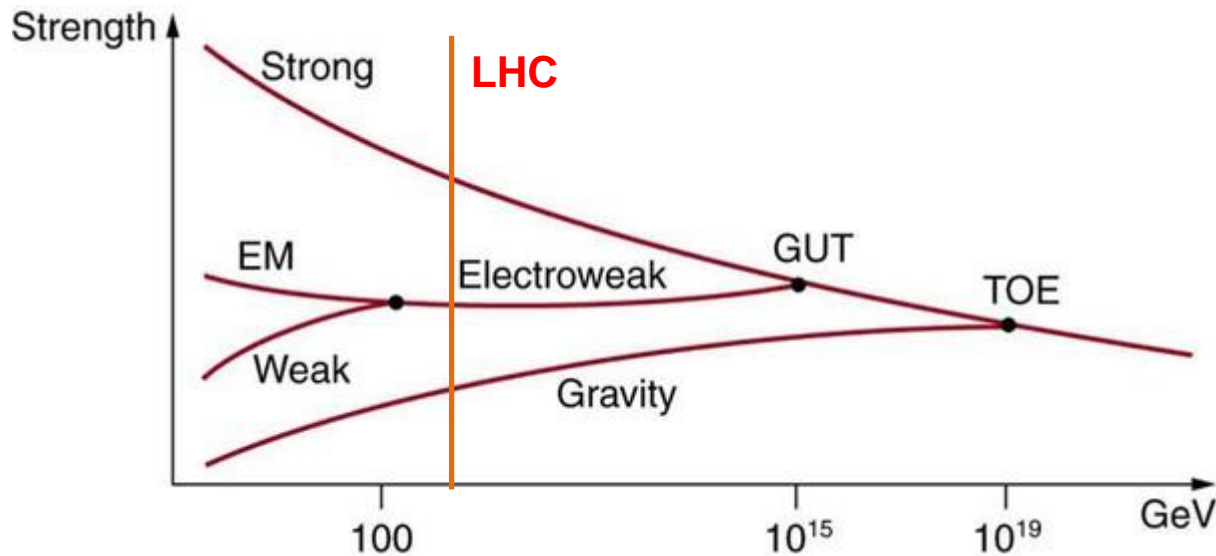
Backing up to the beginning

Using our known physics, we reverse the direction of time to back up toward the beginning of expansion



Backing up to the beginning

Using our known physics, we reverse the direction of time to back up toward the beginning of expansion but our physics breaks down at very high energy densities that must have existed shortly following the Big Bang.



GUTs and TOEs

← Energy →
← Time →

Temperature equivalence:
1eV ~ 11000 K



Backing up to the beginning II

- Note that in the previous diagrams, physics points to a “time zero”.
- Was there anything prior to this time?
- While this model is compatible with our current understanding of physics, we know it cannot describe the very earliest moments of the Universe.
- During the 10^{-30} seconds following our time zero, we know our physics just doesn't work.
- There may well have been a “something” before our “time zero” beginning. We can only speculate.
- Was there a “**before**” the ***Big Bang***?



Next day, we start the formal in-person lectures

- You might make a habit of visiting the [course website](#) as it is there that I shall keep you up-to-date on what we are doing and where we are going.
- You might preview the pre-recorded weekly PowerPoint lectures before attending the lecture sessions.
- Access to course materials is available through [MyCourses](#)

