

## Sc. 10 Unit 4: Astronomy - Lab "Galaxy Grazing"

### If galaxies are all moving apart, how can they collide?

The dynamics of the universe are governed by competing forces whose influence varies with scale, so local forces can override universal forces in discrete regions.

#### 11 Fast Facts:

1. On scales larger than galaxy clusters, all galaxies are moving apart at an ever increasing rate (Hubble's law). The gravitational attraction between two galaxies at that distance is too small to have a significant effect, so the galaxies more or less follow the general flow of the expansion. But it is a different story in a galaxy's local neighbourhood. There the gravitational attraction can be very significant and the interactions much more profound.

#### Role of Dark Energy:

2. Dark energy, believed to be causing the acceleration of the expansion of the universe, provides a constant outward force that does not dilute as the universe expands. Pitted against this relentless push is the gravitational pull from the rest of the matter and energy in the universe.
3. Early on, the universe was much denser than it is today, and the attractive force of gravity was winning the battle, on scales both large and small. Clouds of gas condensed to form stars and galaxies, and galaxies drew together to form clusters.
4. If there had been more matter around (in the early universe), the universe might have started to recollapse before it ever had the chance to accelerate.
5. But matter and energy do dilute as the volume of the universe increases, so dark energy slowly came to dominate. Since about six billion years ago (about a billion years before Earth formed), the expansion has, on average, been accelerating.
6. Galaxies that had been pulled together before the universe began accelerating still have the chance to collide. Collectively they form overdense patches of the universe in which gravity still reigns.
7. In our neighbourhood the Andromeda galaxy, our largest companion, is actually falling toward us, and we will have our first close encounter with it in just a few billion years' time.
8. Our local group comprises Andromeda, the Magellanic Clouds and about 35 other galaxies, all of which lie in an even larger cluster called Virgo.

9. Together we will travel through the expanding universe, and we had better learn to like the company.
10. Any galaxies that have not yet won the gravity war have missed their chance. The universe is now split into pockets of interaction that will drift alone through the expanding cosmos.
11. The galaxies in our group will continue to collide and interact in myriad interesting ways, but we will be forever separated from the other galaxies that are not in our group .