Stellar Population Evolution in Early-type Galaxies

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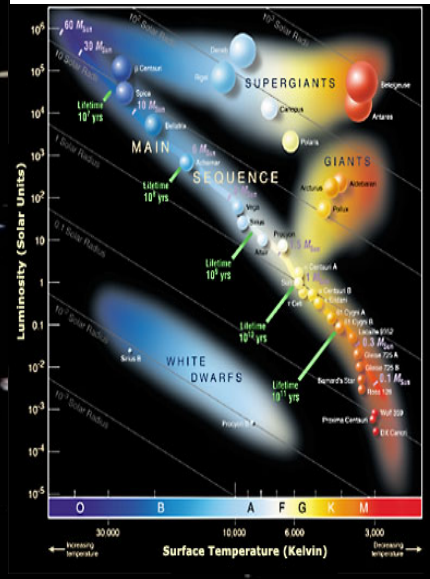
Abstract

Galaxies are complex systems that contain stars and gas. The easiest galaxies to model are early-type galaxies, which have elliptical shapes, smooth images, and are gas-poor. In this project, high-resolution images of galaxies taken with the Hubble Space Telescope are used to estimate how much early-type galaxies have changed in the last 7 billion years. This corresponds to the last half age of the Universe. As one looks back in space and time, stellar populations of galaxies should be younger and should contain more short-lived, luminous stars that have since disappeared. The total amount of light emitted by an object over its area is called “the surface brightness,” a quantity that for galaxies is independent of the distance but evolves with time. Surface brightnesses for a small sample of early-type galaxies will be measured, and the expectation is that in the past, these surface brightness were higher than at present.

Goals

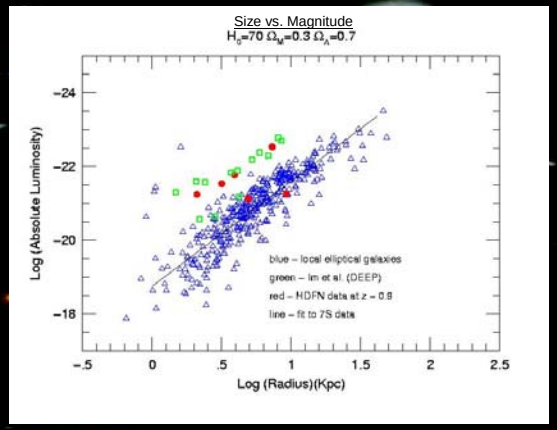
- Compare young galaxies to present day galaxies.
- Verify that galaxies in the past were brighter than present day galaxies.
- Model how the stellar populations in galaxies change with time.
- Find out when galaxies formed their stars.

Hertzsprung-Russell diagram

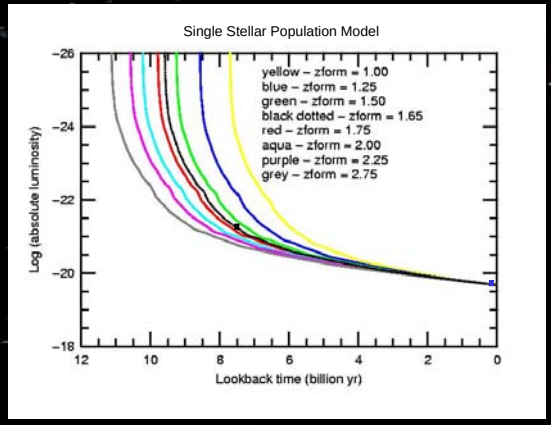


The Hertzsprung-Russell diagram is a plot of stellar luminosity vs. temperature. The diagram above shows the evolutionary track of a star. The most massive stars have the most fuel but they also use it up faster. Thus, they leave the main sequence sooner than lower mass stars and eventually burn themselves out. This means that high surface brightness in a galaxy is a good indicator that its stellar population is young. I compared the surface brightness of local galaxies to that of galaxies at very large distances when their stellar populations were younger.

Findings
Galaxies at z~1 are brighter



Best fit is at z=1.65



Conclusions

- The Size vs. Magnitude plot at left shows that galaxies at high redshift are brighter by about 1.5 mag. This means that 7 billion years ago galaxies were four times more luminous than today.
- A Single stellar population model (lower left) shows that galaxies formed their stars around 9.5 billion years ago. This means that at the epoch that we observe them the stellar populations were about 2.5 billion years old.

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