Gravitational Instabilities and Galaxy Evolution

For Prelims: Gravitational Instabilities and Galaxy Evolution, **Indian Institute of Astrophysics (IIA)**, Gravitational Instabilities, Spitzer Photometry and Accurate Rotation Curves (SPARC).

For Mains: Gravitational Instabilities and Galaxy Evolution.

Source: TH

Why in News?

Recently, a study has been conducted by the **Indian Institute of Astrophysics (IIA)**, aiming to comprehend the **relationship between Gravitational Instabilities and Galaxy Evolution.**

Note:

- Gravitational Instabilities refer to a **fundamental physical phenomenon that occurs in astrophysical systems**, particularly in celestial bodies like galaxies**,** stars**, and** planetary systems**.**
- These instabilities are driven by the force of **gravity** and play a crucial role in **shaping the structure, evolution, and dynamics of these cosmic entities.**

What is the Methodology of the Study?

- Researchers compared **star formation rates, gas fractions,** and time scales for gravitational instability growth in nearby galaxies by analysing the **stability levels of a sample of 175 galaxies** from the **Spitzer Photometry and Accurate Rotation Curves (SPARC) database.**
- The study investigated **how stability levels in galaxies are regulated,** including the potential role of **dark matter.** It sought to **determine whether stars and gas can self-regulate stability levels.**
- They compared **stability levels in nearby galaxies with those observed at high redshifts,** which are considered precursors to galaxies in the local universe.

Redshift:

- Scientists **measure cosmic distances via redshift**, the extent to which light is shifted towards the **red (lower energy) part of the** electromagnetic spectrum during its long journey across the universe.
    - **The greater the distance, the higher the redshift.**

What are the Key Highlights of the Study?

- **Spiral Galaxies:**
  - **Spiral galaxies**, such as the **Milky Way**, exhibited specific characteristics.
    - They had **a higher median star formation rate**, lower stability, reduced gas fraction, and **a smaller time scale** for the growth of gravitational instabilities.
- **Conversion of Gas to Stars:**
  - In spiral galaxies with lower stability, **gravitational instabilities efficiently convert a significant amount** of gas into stars.
    - This process led to the depletion of gas reservoirs in these galaxies.
- **Star Formation Mechanism:**
  - The galaxies with marginal stability **levels undergo intense star formation** activity for a short time scale, depleting gas reserves.
  - In contrast, **highly stable galaxies exhibit slower and gradual star formation** processes over longer time scales, converting available gas into stars.
- **Future & Significance:**
  - There is a **need for future investigations into the impact of gravitational instabilities** on the morphological evolution of galaxies across different redshifts.
  - These insights are **crucial for understanding fundamental processes in galaxy formation and evolution.**