

Discussion: magnetic fields (MF) in evolving disk galaxies

Chair: Tigran Arshakian

Ideal model – dependent on cosmology model:

- Structure formation and magnetic structure are interconnected.
- Processes near the central black hole regulates the kpc-structure of a galaxy and structure of the IGM on scales of hundred of kpc to a few Mpc.

Focus on epochs of formation of star-forming disk galaxies (SFG).

Aim: Develop a strategy for building a **simple model** for a SFG.

1. Evolution from observations.
2. Models of MF evolution (Sokoloff, Moss, Hanasz, Elstner, Dubois).
3. Discussion to define key properties of a simple model.
 1. Initial settings.
 2. Mechanism of amplification; evolution of key parameters.
4. Evolution of MF in merging systems (Soida, Kotarba (see a poster)).

Characteristics of evolving disk galaxies: observations

Key parameters:

- Star-formation rate, $\text{SFR}(z)$ is high in young galaxies: increases with z .
- SF regions: homogeneous at present time; clumpy at $z \sim 2$ (Swinbank et al 2010).
- Disk-size downsizing: $R(z) \sim 1/(1+z)^{(0.5-1.5)}$ (e.g. Trujillo et al. 2006).
- Evolution of $h(z)/R(z)$: increases ~ 2 times between $z \sim 0$ and $z \sim 1$ (Elmegreen et al. 2005).
- Turbulence velocity in local galaxies: almost constant for $\text{SFR} < 5 \text{ M}_{\text{sun}} \text{ yr}^{-1}$; positive for higher SFR (Dib et al. 2006).
- Regular magnetic fields at high- z :
 - Regular fields (~ 10 microG) exist at $z \sim 1-2$ (RM of pol. QSOs; Kronberg et al. 2008; Bernet et al. 2008).
 - Strong total fields up to $z \sim 3$ and even larger z (Radio-IR corr.: Murphy 2009).

Questions:

- Outflow/inflow change with cosmological epoch?
- Gas density evolution?
- CR density evolution?

Evolution of magnetic fields in disk galaxies: simulations

Undisturbed galaxy-model (time-scale: several Gyr)

- Simple dynamo models (Sokoloff, Moss)
- MHD simulations (Hanasz, Otmanowska-Mazur)

Merging galaxies (few Gyr).

- Antennae system (Kotarba)

First disk galaxies: discussion

Key Drivers:

- SFR (typical size and lifetime of SF regions).
- Turbulence (SN explosions, MRI, accretion of IGM, ...)
- Mechanism of amplification and ordering of MFs.
- Galaxy rotation.

First disk galaxies: discussion

Questions:

- MHD models against dynamo models.
- What is the initial configuration of seed fields (spotty and/or homogeneous) and their amplitude?
- The amplitude of seed fields in the disk ($\sim 10^{-7}$ G)?
- Is dynamo the only mechanism to amplify the seed fields?
Times scales of amplification and ordering?
- Dynamo model for a thick disk of young galaxies?

- Does the turbulence velocity increase with increasing the SFR?
- Galaxy-size evolution?
- How does the cluster environment influence the evolution?

- What is the influence of the major/minor merger on:
 - the structure and amplitude of the turbulent and regular fields in SFG?
 - the coherent scale of the regular field?