Magnetic fields in interacting galaxies and galactic haloes

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Magnetic fields in galaxies

M51 6cm Tot.Int.+B-Vectors (VLA+Effelsberg) Copyright MPIR Bonn (A.Fletcher & R.Beck)

M51 – Whirlpool Galaxy (10 - 30 µGauss)

Total synchrotron intensity + total magnetic field 6cm VLA + Effelsberg (Fletcher et al. 2005)



- 1.) Idealized disk galaxies Minor mergers Stephan's Quintet
- 2.) Cosmological galactic haloes Primordial seeding Supernova seeding

Numerical method

 $\frac{\partial \boldsymbol{B}}{\partial t} = \boldsymbol{\nabla} \times (\boldsymbol{v} \times \boldsymbol{B}) + \eta \Delta \boldsymbol{B}$



Initial conditions

- Idealized disk galaxies
 DM halo, Gas disk, Star disk/bulge
 Ambient IGM gas
 Uniform magnetic seed field 10⁻⁹ G
- Cosmological galactic halo MW-like properties Uniform magnetic seed field 10⁻¹⁸ G Supernova seeded magnetic field 10⁻⁹ G/Gyr

SPMHD Code Gadget3

- **Basic implementation:** Dolag & Stasyszyn 2009, Price 2012
- Non-Ideal MHD: Bonafede, et al., 2011
- Cleaning scheme: Stasyszyn, Dolag & Beck 2012
- Visualization with P-Smac2: Donnert, et al, in prep.



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Magnetic growth and saturation in galaxy minor mergers

Stephan's Quintet (Geng, Beck, et al., 2012b)



Following magnetic fields and radio emission

Primordial seeding (Beck, et al., 2012)



Magnetic field during cosmological formation of a halo (tracing star formation, multi mergers and turbulence)

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Primordial seeding (Beck, et al., 2012)



Main findings:

- Saturation value is independent of the seed field strength
- Simple analytical model helps to interpret the simulations

Supernova seeding (Beck A., in prep.)





Direct seeding by supernovae with a local dipole shape

0

log(n) part/cm³ comoving

Supernova seeding (Beck A., in prep.)



Summary



- Growth and saturation of magnetic field in idealized galactic merger scenarios
- Growth of primordial or
 supernova seeded field to μG
 level during the formation of a
 galactic halo
- **Creation of mock observations**
- Failure to produce a galactic disk
- Sub-grid connection of magnetic fields and star formation model has to be investigated