Rapid Growth of ISM Magnetic Fields via a Fast Turbulent Dynamo

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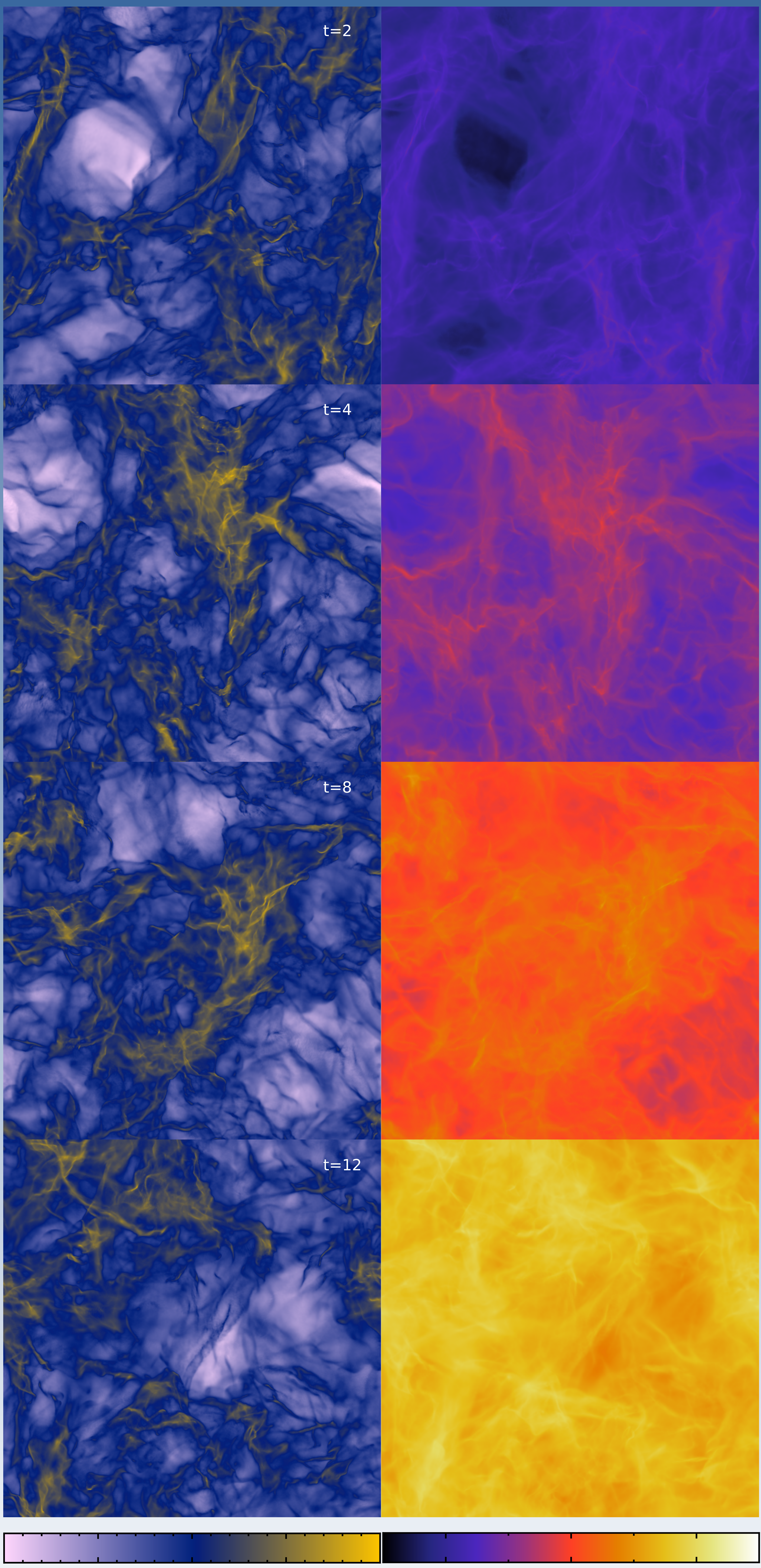
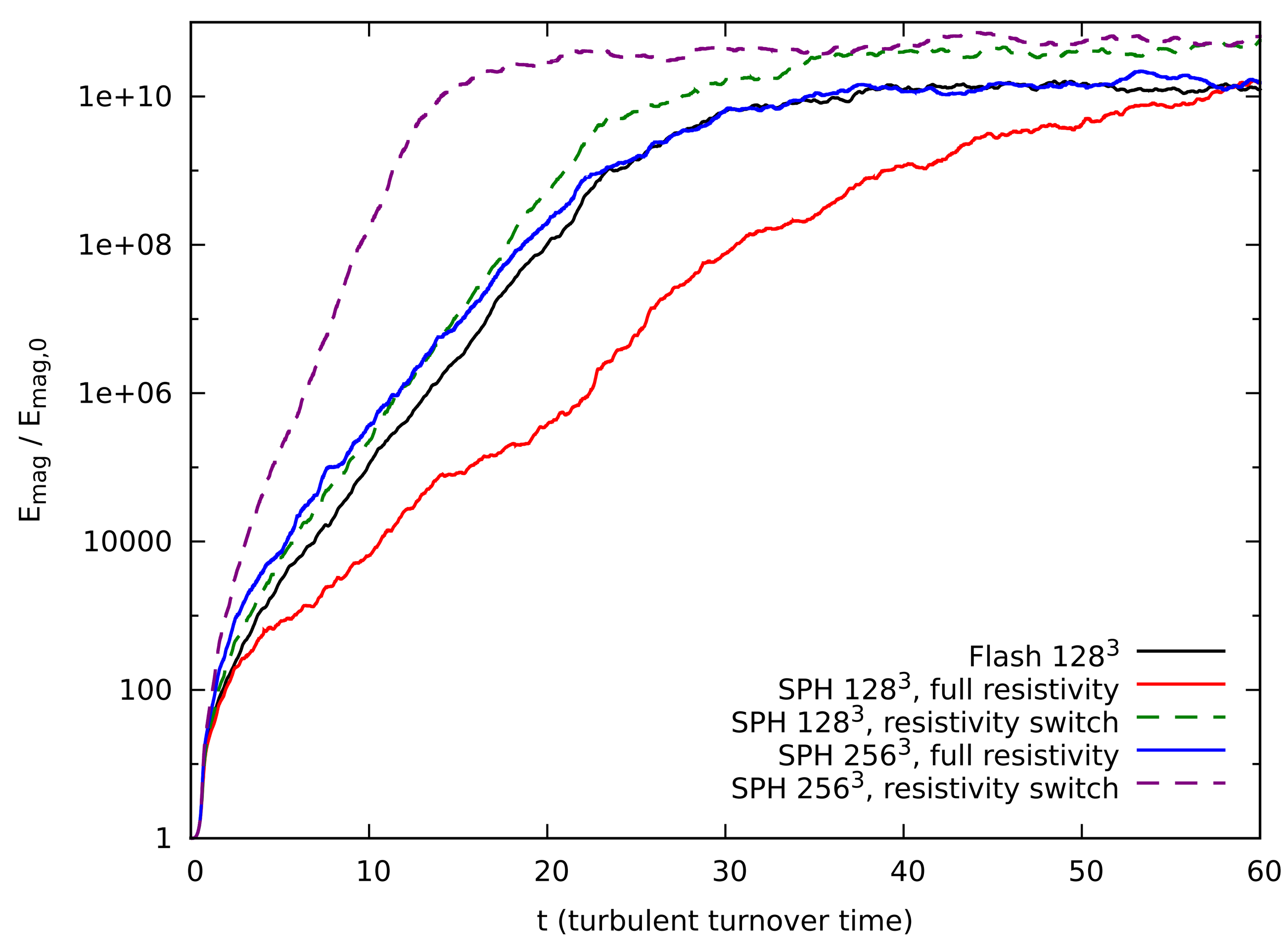
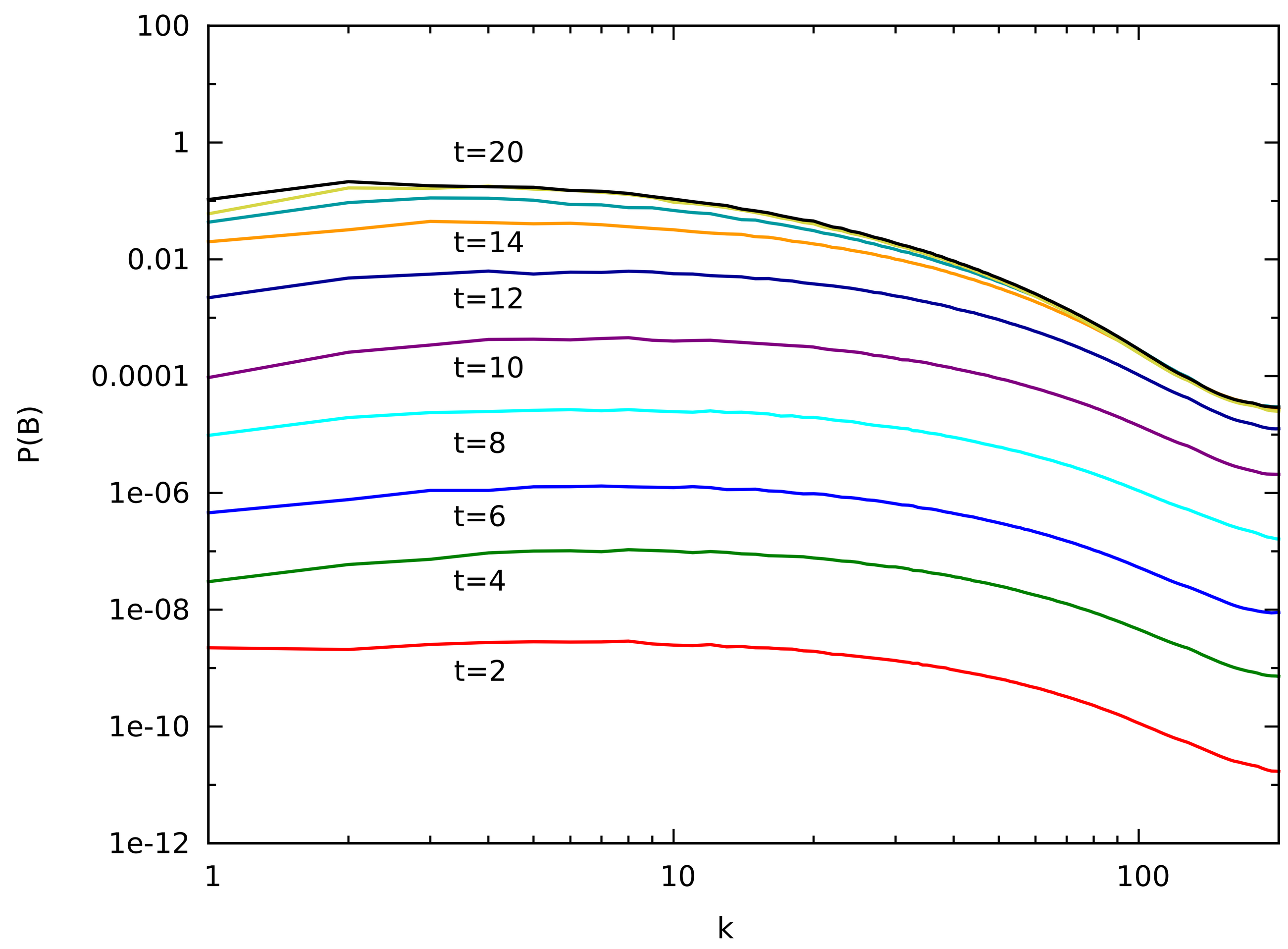
Density | Magnetic field





The SPH growth rate of magnetic energy increases as the dissipation is decreased, either by increasing resolution or by using the new artificial resistivity switch. The growth rates and saturation levels are similar to results from the grid based code Flash.



The magnetic energy spectra shows that the magnetic field grows equally on all scales, but saturates first on the smallest scale (high k).

Summary:

Supersonic turbulence in molecular clouds exponentially increase magnetic fields through the conversion of turbulent energy until magnetic energy is a few percent of kinetic energy. The growth rate increases with the magnetic Prandtl number, the ratio of viscous to magnetic dissipation (in molecular clouds, Pm~10^6). Our simulated growth rates (Pm~1) increases as the dissipation is reduced, and suggest that magnetic fields within molecular clouds should reach saturation within the clouds lifetime.

Numerical Details:

We have simulated isothermal, driven, Mach 10 turbulence using Smoothed Particle Magnetohydrodynamics with initial magnetic energy 10^{10} smaller than kinetic energy. SPH has previously been shown to agree with grid based methods on the statistics of supersonic turbulence (Price & Federrath 2010). We use a new artificial resistivity switch designed to reduce numerical dissipation, and show for the first time that SPH produces similar magnetic energy growth rates to grid based methods (compared here against Flash).

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