P 22: Theorie/Modellierung II

Zeit: Donnerstag 12:10–13:05 Raum: HS Biochemie (groß)

Fachvortrag P 22.1 Do 12:10 HS Biochemie (groß)

Nonlinear MHD dynamo simulations in spherical geometry — •Klaus Reuter and Frank Jenko — Max-Planck-Institut für Plasmaphysik

The MHD dynamo process is commonly believed to cause e.g. planetary and stellar magnetic fields. In recent years, several experiments which use turbulent flows of liquid sodium were performed to study dynamo action in the laboratory. We present numerical simulations of a mechanically driven, electrically conducting flow in spherical geometry which consists of two counter-rotating flow cells, similar to the flow realized in the Madison Dynamo Experiment. The aims of these studies are to better understand the underlying physics and to possibly optimize the experimental setup.

At low Reynolds numbers Re, a hydrodynamic instability gives rise to propagating wave features which can either support or hinder dynamo action, depending on their spatio-temporal properties. Turbulent fluctuations which appear at higher Re strongly inhibit the dynamo process. The resulting critical magnetic Reynolds number $\mathrm{Rm_c}(\mathrm{Re})$ above which magnetic field amplification sets in is presented.

Finally, it is shown that the turbulent flow allows for subcritical dynamo action. These subcritical dynamo states can either be reached by suddenly reducing the magnetic Reynolds number of the fluid, or by applying external finite amplitude magnetic fields. The latter finding may be useful for the dynamo experiment to reach self-excitation.

P 22.2 Do 12:35 HS Biochemie (groß)

The saturation of the electron beam filamentation instability by the self-generated magnetic field and magnetic pressure gradient-driven electric field — •Mark Eric Dieckmann[1,2], George Rowlands[3], Ioannis Kourakis[4], and Marco Borghesi[4] — [1]Department of Science and Technology, Linköping University, Sweden — [2]Institut fuer Theoretische Physik IV, Ruhr-Universität Bochum — [3]Physics Department, Warwick University, U.K. — [4]Centre for Plasma Physics, Queen's University Belfast, U.K.

Two counter-propagating cool and equally dense electron beams are modelled with PIC simulations. The filamentation instability is examined in one spatial dimension. The box length resolves one pair of current filaments. It is demonstrated, that the force on the electrons imposed by the electrostatic field, which develops during the nonlinear stage of the instability, oscillates around a mean value that equals the magnetic pressure gradient force. The forces acting on the electrons due to the electrostatic and the magnetic field have a similar strength. The electrostatic field reduces the confining force close to the stable equilibrium of each filament and increases it farther away. The confining potential is not sinusoidal, and it permits an overlap of current filaments with an opposite flow direction. The scaling of the saturation amplitude of the magnetic field with the filament size differs from that expected from the magnetic trapping model. The latter nevertheless gives a good estimate for the magnetic saturation amplitude.

P 22.3 Do 12:50 HS Biochemie (groß)

Elektronenstrahl-angeregte Whistler-Oszillitonen: Theorie und PIC-Simulationen — •Konrad Sauer und Richard Sydora — University of Alberta, Edmonton, Alberta, Canada

Die Anregung von Whistlerwellen durch eine Elektronen-Temperaturanisotropie mit $T_{e\perp} > T_{e\parallel}$ ist in der Literatur gut untersucht worden. Komplizierter sind die Verhältnisse bei Instabilitäten durch (isotrope) Elektronenstrahlen, da Whistler nur bei Ausbreitung schief zum Magnetfeld instabil werden und eine umfassendere Dispersionsanalyse erfordern. Je nach Geschwindigkeit des Strahls V_b in bezug auf die Elektronen-Alfvengeschwindigkeit V_{Ae} können zwei unterschiedliche Mechanismen der Strahl-Plasma-Wechselwirkung auftreten. Im Fall $V_b \leq 0.5 \cdot V_{Ae}$ kommt es zur Wechselwirkung der Strahlmode $\omega - k_\parallel V_b$ mit der Whistlerwelle (Cherenkov-Instabilität). Bei Strahlgeschwindigkeiten oberhalb von $V_b \sim 2V_{Ae}$ wird die Instabiltät durch die Doppler-verschobene Mode $\omega = -\Omega_e + k_\parallel V_b$ verursacht (zyklotron-artige Instabilität). Untersuchungen über die raum-zeitliche Entwicklung beider Instabilitäten bis zum Erreichen eines quasi-stationären Zustandes erfolgt mit Hilfe von 1D PIC- (particle in-cell) Simulationen. Im Ergebnis zeigt sich, dass die quasi-stationären Strukturen in ihren Eigenschaften mit denen von Whistler-Oszillitonen übereinstimmen, die man als stationäre nichtlineare Lösungen der zugehörigen Fluidgleichungen erhält. Jüngste Satelliten-Messungen kohärenter Whistler-Emissionen in Winkelbereichen um etwa 50° zum Magnetfeld werden auf der Basis dieser Ergebnisse interpretiert.