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Nota di contenuto	The Magnetic Universe Geophysical and Astrophysical Dynamo Theory; Contents; Preface; 1 Introduction; 2 Earth and Planets; 2.1 Observational Overview; 2.1.1 Reversals; 2.1.2 Other Time-Variability; 2.2 Basic Equations and Parameters; 2.2.1 Anelastic and Boussinesq Equations; 2.2.2 Nondimensionalization; 2.3 Magnetoconvection; 2.3.1 Rotation or Magnetism Alone; 2.3.2 Rotation and Magnetism Together; 2.3.3 Weak versus Strong Fields; 2.3.4 Oscillatory Convection Modes; 2.4 Taylor's Constraint; 2.4.1 Taylor's Original Analysis; 2.4.2 Relaxation of $Ro = E = 0$ ; 2.4.3 Taylor States versus Ekman States; 2.4.4 From Ekman States to Taylor States; 2.4.5 Torsional Oscillations; 2.4.6 -Dynamos; 2.4.7 Taylor's Constraint in the Anelastic Approximation; 2.5 Hydromagnetic Waves; 2.6 The Inner Core; 2.6.1 Stewartson Layers on C; 2.6.2 Nonaxisymmetric Shear Layers on C; 2.6.3 Finite Conductivity of the Inner Core; 2.6.4 Rotation of the Inner Core; 2.7 Numerical Simulations; 2.8 Magnetic Instabilities; 2.9 Other Planets; 2.9.1 Mercury, Venus and

Mars; 2.9.2 Jupiter's Moons; 2.9.3 Jupiter and Saturn; 2.9.4 Uranus and Neptune; 3 Differential Rotation Theory  
 3.1 The Solar Rotation 3.1.1 Torsional Oscillations; 3.1.2 Meridional Flow; 3.1.3 Ward's Correlation; 3.1.4 Stellar Observations; 3.2 Angular Momentum Transport in Convection Zones; 3.2.1 The Taylor Number Puzzle; 3.2.2 The  $\alpha$ -Effect; 3.2.3 The Eddy Viscosity Tensor; 3.2.4 Mean-Field Thermodynamics; 3.3 Differential Rotation and Meridional Circulation for Solar-Type Stars; 3.4 Kinetic Helicity and the DIV-CURL-Correlation; 3.5 Overshoot Region and the Tachocline; 3.5.1 The NIRVANA Code; 3.5.2 Penetration into the Stable Layer; 3.5.3 A Magnetic Theory of the Solar Tachocline  
 4 The Stellar Dynamo 4.1 The Solar-Stellar Connection; 4.1.1 The Phase Relation; 4.1.2 The Nonlinear Cycle; 4.1.3 Parity; 4.1.4 Dynamo-related Stellar Observations; 4.1.5 The Flip-Flop Phenomenon; 4.1.6 More Cyclicities; 4.2 The  $\alpha$ -Tensor; 4.2.1 The Magnetic-Field Advection; 4.2.2 The Highly Anisotropic  $\alpha$ -Effect; 4.2.3 The Magnetic Quenching of the  $\alpha$ -Effect; 4.2.4 Weak-Compressible Turbulence; 4.3 Magnetic-Diffusivity Tensor and  $\alpha$ -Quenching; 4.3.1 The Eddy Diffusivity Tensor; 4.3.2 Sunspot Decay; 4.4 Mean-Field Stellar Dynamo Models; 4.4.1 The (2)-Dynamo; 4.4.2 The  $\alpha$ -Dynamo for Slow Rotation  
 4.4.3 Meridional Flow Influence 4.5 The Solar Dynamo; 4.5.1 The Overshoot Dynamo; 4.5.2 The Advection-Dominated Dynamo; 4.6 Dynamos with Random  $\alpha$ ; 4.6.1 A Turbulence Model; 4.6.2 Dynamo Models with Fluctuating  $\alpha$ -Effect; 4.7 Nonlinear Dynamo Models; 4.7.1 Malkus-Proctor Mechanism; 4.7.2  $\alpha$ -Quenching; 4.7.3 Magnetic Saturation by Turbulent Pumping; 4.7.4  $\alpha$ -Quenching; 4.8  $\alpha$ -Quenching and Maunder Minimum; 5 The Magnetorotational Instability (MRI); 5.1 Star Formation; 5.1.1 Molecular Clouds; 5.1.2 The Angular Momentum Problem; 5.1.3 Turbulence and Planet Formation  
 5.2 Stability of Differential Rotation in Hydrodynamics

Sommario/riassunto

Magnetism is one of the most pervasive features of the Universe, with planets, stars and entire galaxies all having associated magnetic fields. All of these fields are generated by the motion of electrically conducting fluids, the so-called dynamo effect. The precise details of what drives the motion, and indeed what the fluid consists of, differ widely though. In this work the authors draw upon their expertise in geophysical and astrophysical MHD to explore some of these phenomena, and describe the similarities and differences between different magnetized objects. They also explain why magn

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