



MHD Dynamo phenomenon in our lab (Petrus Peregrinus Medal Lecture)

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Celestial objects generate magnetic field very like technical dynamo do. Field induces current in a moving electroconductor. The induced current amplifies magnetic field. At large enough product *conductivity time's velocity time's size* amplification exceeds losses and situation without magnetic field is impossible. Such scenario is obvious for technical dynamo made from insulated wire but not so for uniform conductor as in celestial bodies. Development of the idea took literally the entire 20th century. Discovery of sunspot magnetic fields at the century rise and laboratory verification at the very fall. At thirties Cowling noticed that geometrically simple shaped (axially symmetrical) field can't sustain itself. Process must be more complex, somehow spatially fragmented. At the middle of century Parker and Steenbeck saw such fragmentation in a turbulent structure of hydrodynamic flow. Shortly after his α -effect approach was made ready Steenbeck invited us to think on molten Na experiments for theory verification.

The first idea was to push the Na flow through the hand-blown pipe maze. Similar industrial scale experiment after years and regardless of us was realized in Karlsruhe. Seeking for something cheaper we stopped at Ponomarenko idea – axially symmetric helical flow can't generate axi-symmetric field but it can generate azimuthally structured one. The mathematical model was modified to experimental conditions and numerically optimized. The Dynamo stand was built and it works.

Even after optimization Dynamo stand exceeds usual size of hydraulic experiments.

2m³ of molten Na circulate there by means of propeller powered from 200kW motor.

When circulation exceeds 0.6 m³/s (at 120°C) seemingly from nowhere appears magnetic field. Twisted field pattern slowly (about 1.5Hz) rotates round flow axis. Up to 0.1T field stay as long as stay circulation and temperature. When sodium is heated up or slowed down the field is slowly dying out.

Phenomenon is much richer than underlining mathematical model. Followed by dozens of fields sensor it shows lot of anomalies and variations. More details in the lecture.