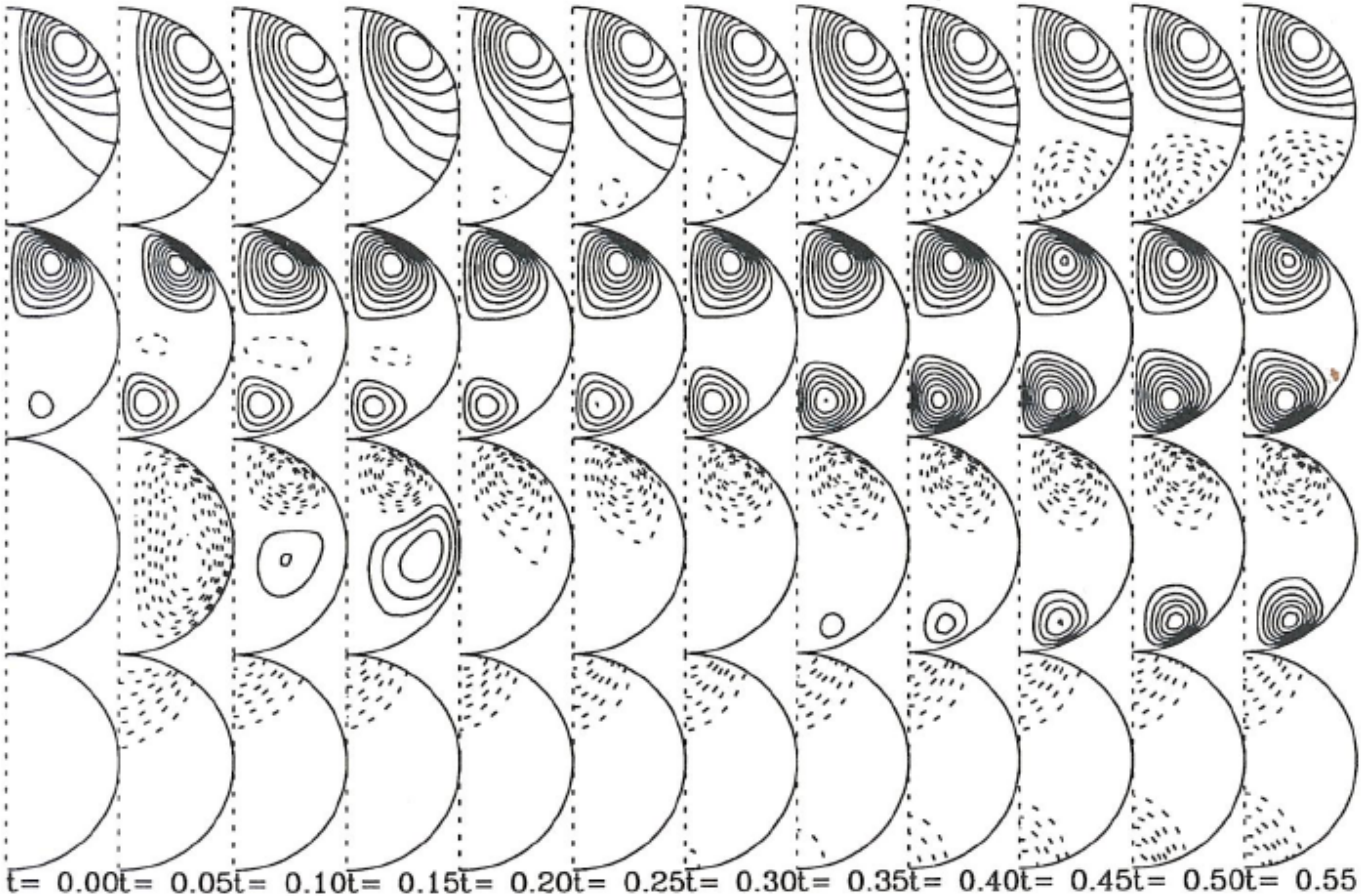
Malkus-Proctor → Galloway-Proctor

& happy Birthday, Mike!

Second International Dynamo Workshop

In October 1979 the Czechoslovakian Academy of Sciences organized at Alsovice an international workshop on Dynamo theory and the generation of the Earth's magnetic field. The sequel to that workshop, on Earth's core boundary and geodynamos, was held at Liblice Castle near Prague from June 27 to July 2, 1988, and attended by 36 scientists from 10 countries. This SEDI Workshop ran simultaneously with a second, and slightly larger, workshop on New trends in geomagnetism - Modern methods and data bases in rock magnetism and paleomagnetism. Participants from each workshop occasionally and informally attended sessions of the other. The two workshops came together in social activities, and in particular for the celebration of the 60th birthday of Dr. V. Buc ha, the director of the Czechoslovakian Institute of Geophysics. Thanks to the tireless organizational efforts of Ivan Cupal, the workshop was very successful. Paul Roberts, who served as the Western coordinator of the workshop has prepared a full repor t. Copies of the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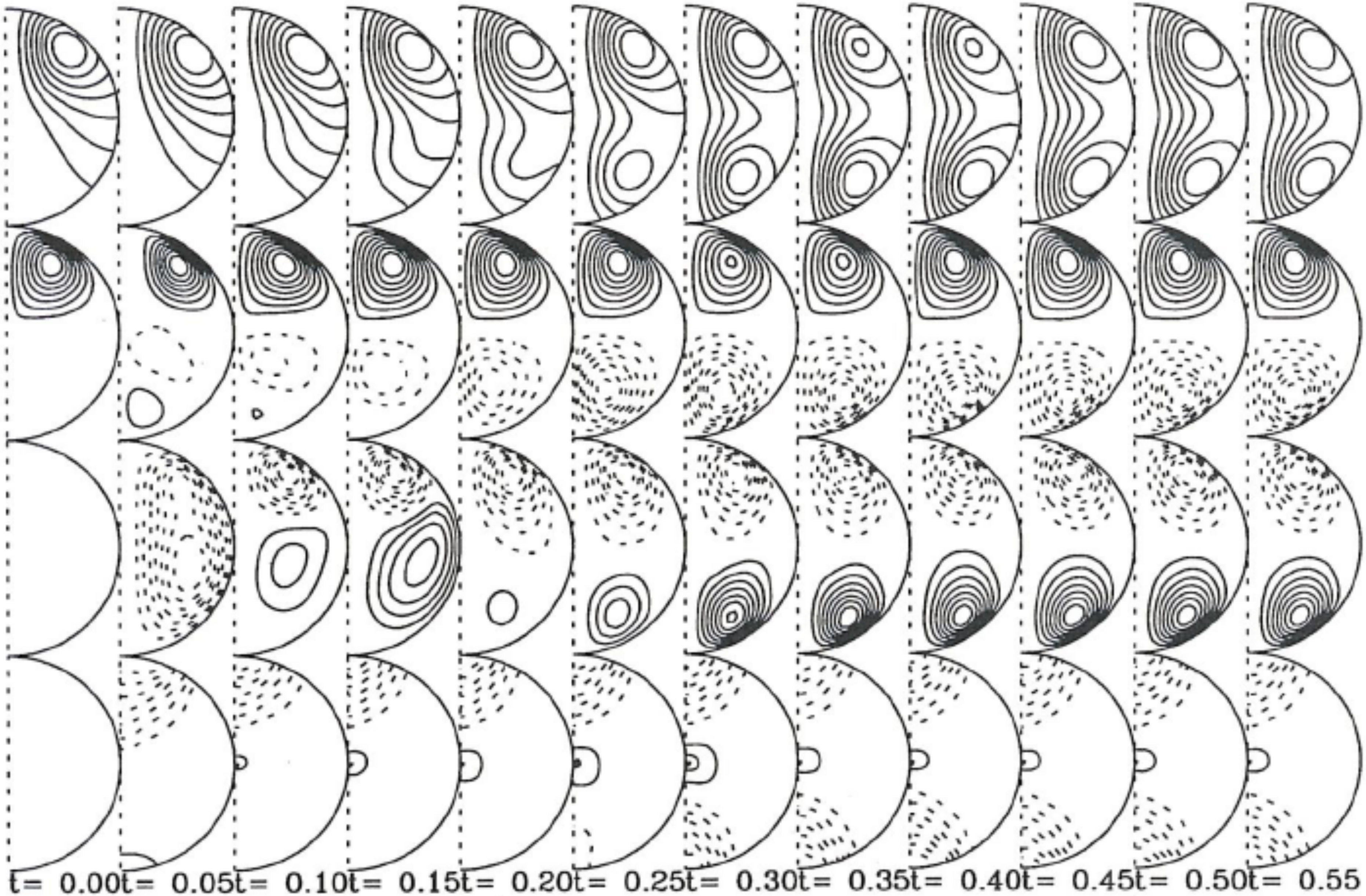
t= 0.50
t= 0.55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t= 0.55

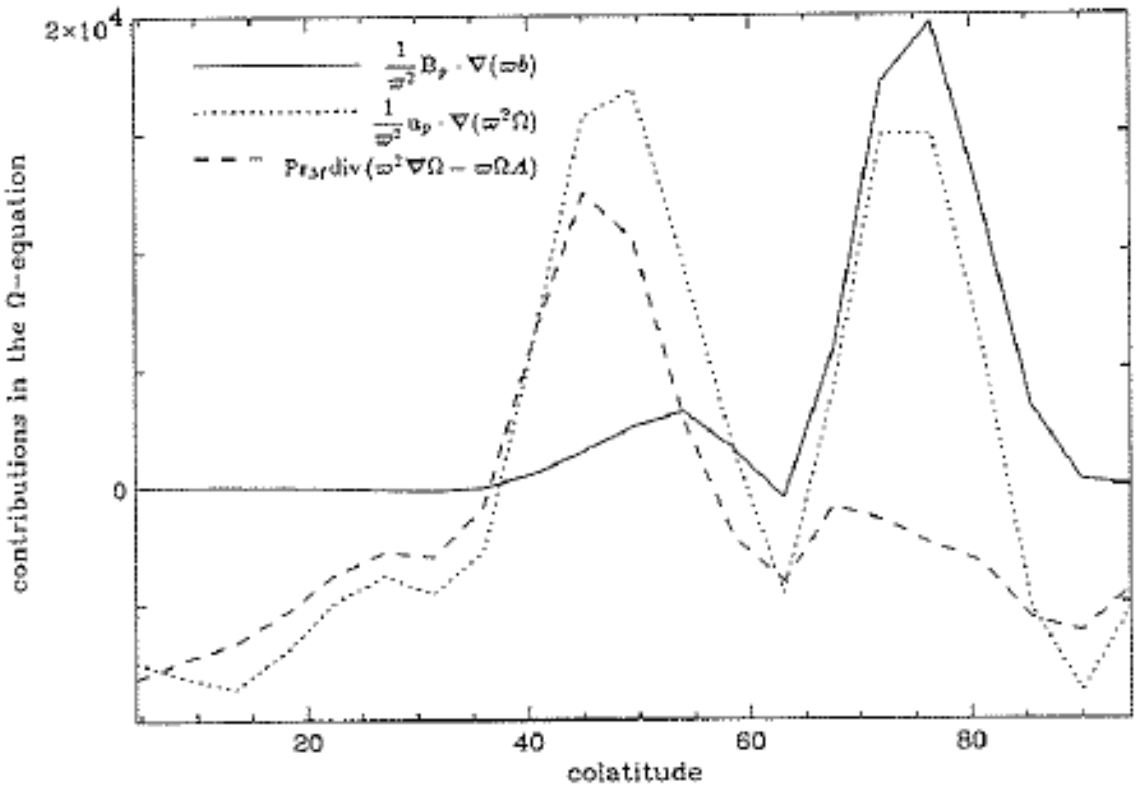
From Malkus-Proctor to …

$$\mathbf{u} = \varpi\Omega\hat{\boldsymbol{\varphi}} + \nabla\times\psi\hat{\boldsymbol{\varphi}}$$

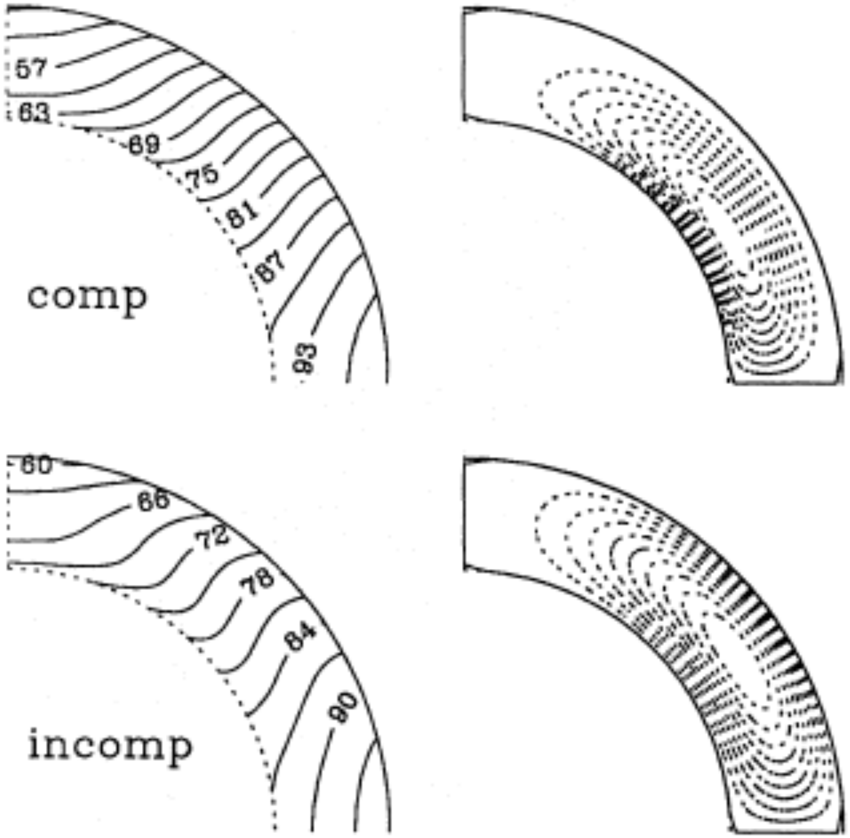
$$\mathbf{B} = b\hat{\boldsymbol{\varphi}} + \nabla\times a\hat{\boldsymbol{\varphi}}$$

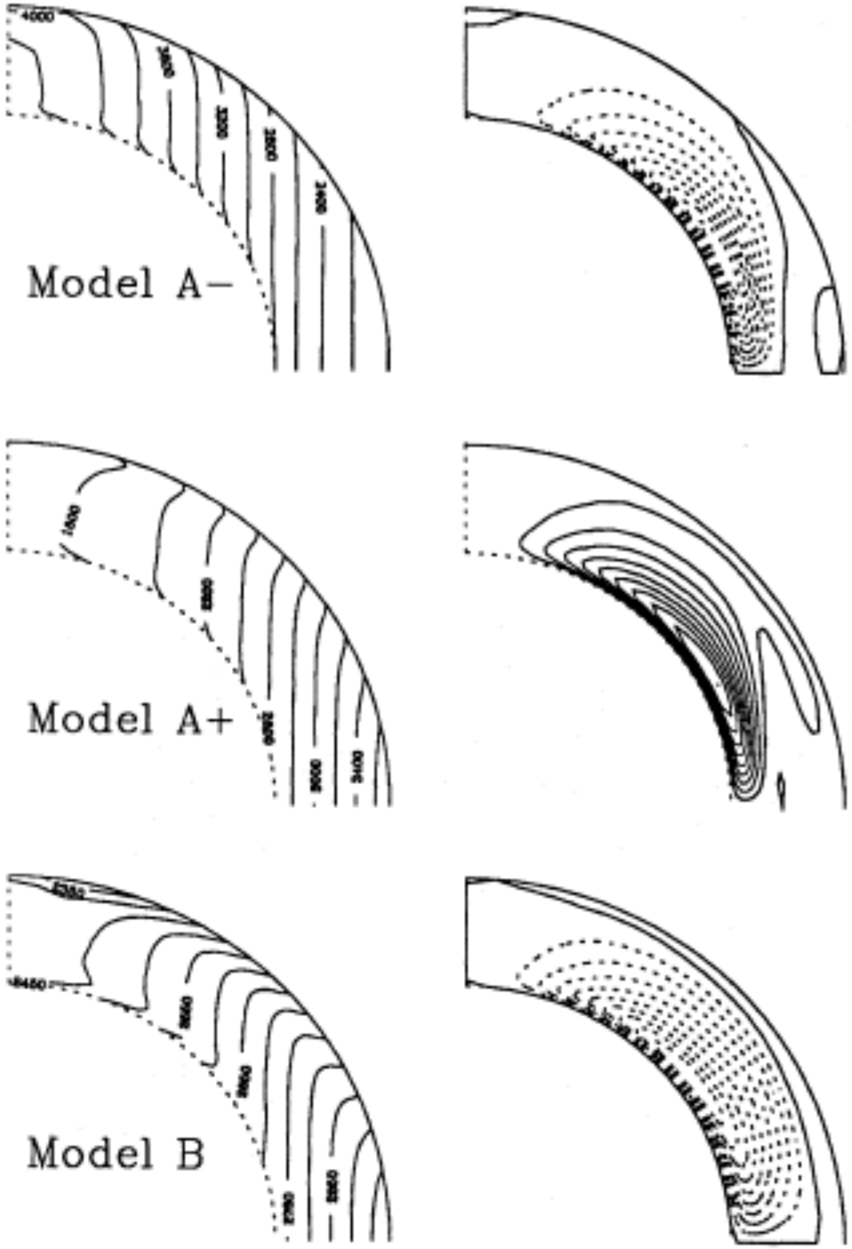
$$\varpi^2\frac{\partial\Omega}{\partial t} = -\mathbf{u}\cdot\nabla\varpi^2\Omega + \mathbf{B}\cdot\nabla\varpi b + \nu\nabla\cdot(\nabla\varpi^2\Omega - \varpi\Omega\Lambda)$$

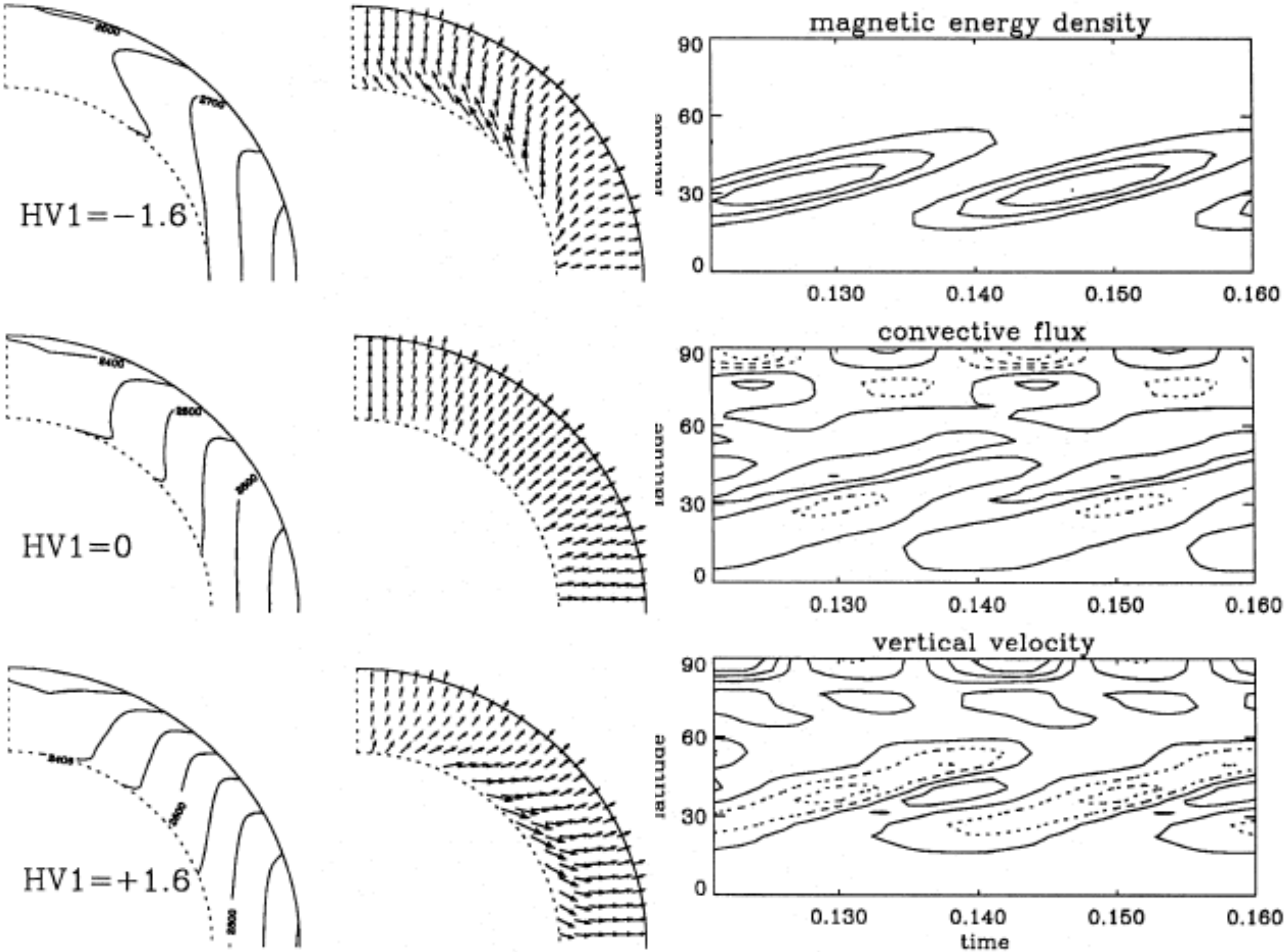
Elsasser number
Close to 1



Compressibility

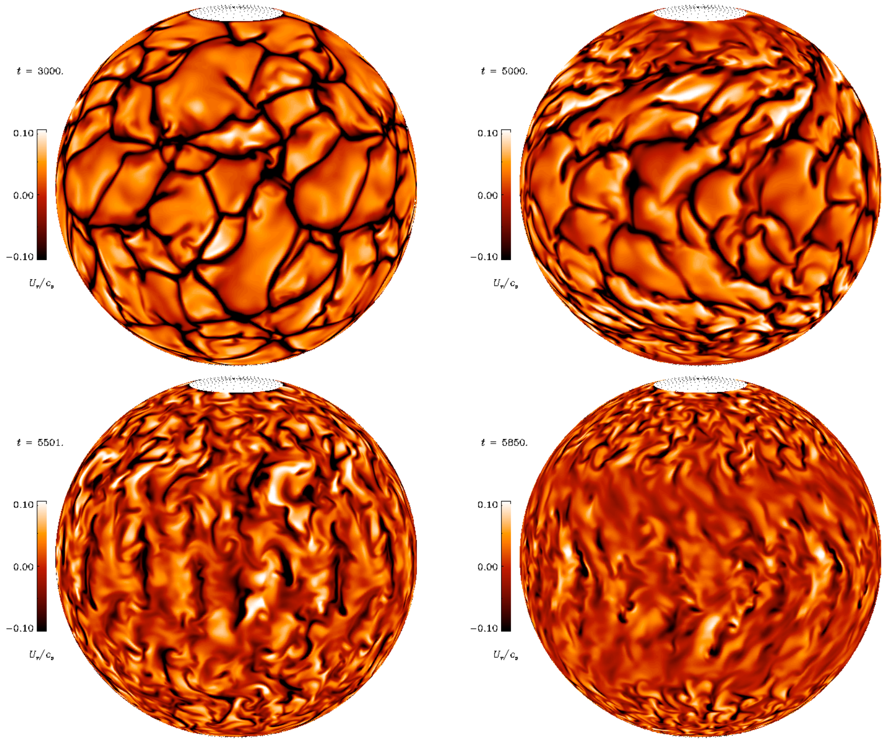


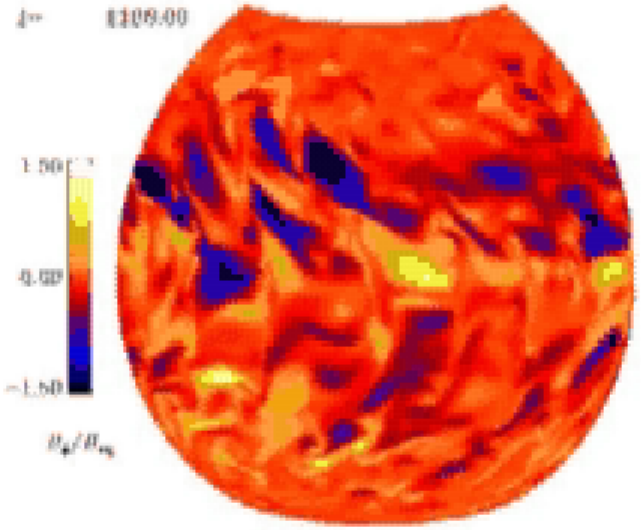


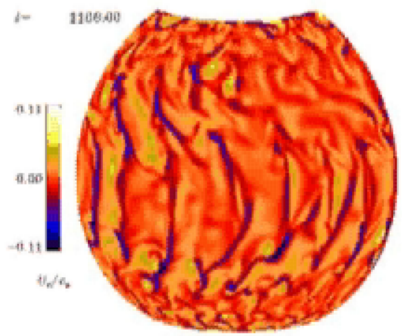

HV1=−1.6
HV1=0
HV1=+1.6
magnetic energy density
convective flux
vertical velocity
latitude
0
30
60
90
0.130
0.140
0.150
0.160
time

Spherical simulation w/ Pencil Code

Equatorward migration
Just like 30 years ago
(Gilman/Glatzmaier)

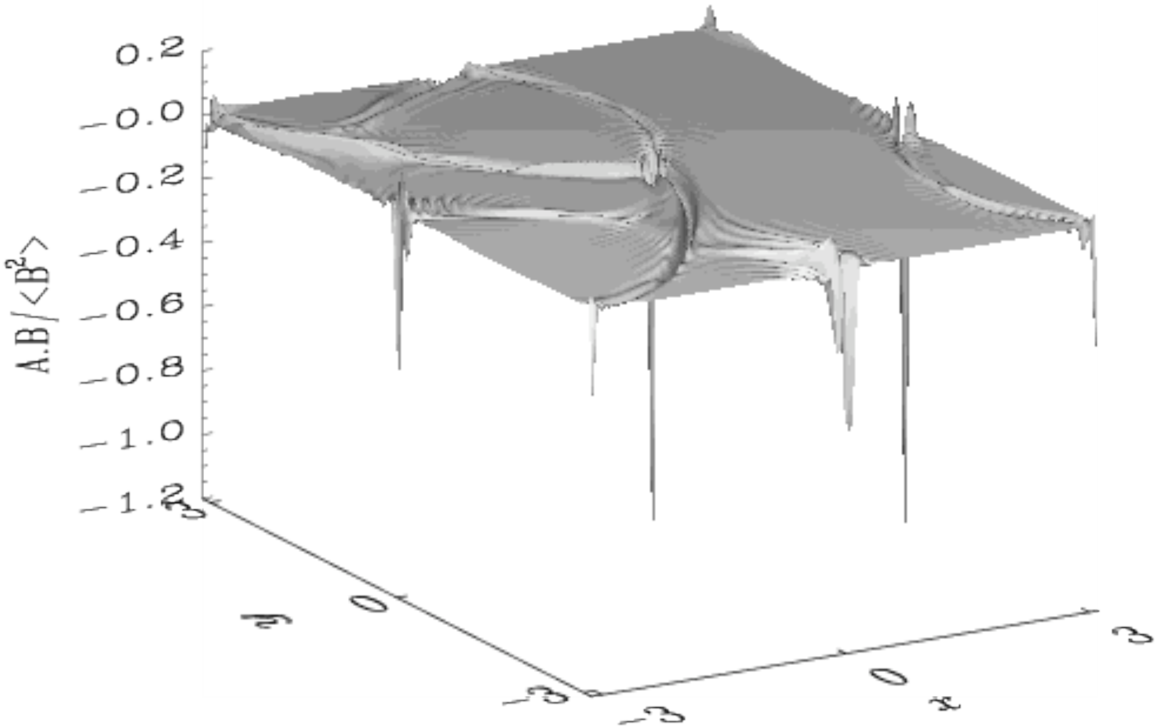






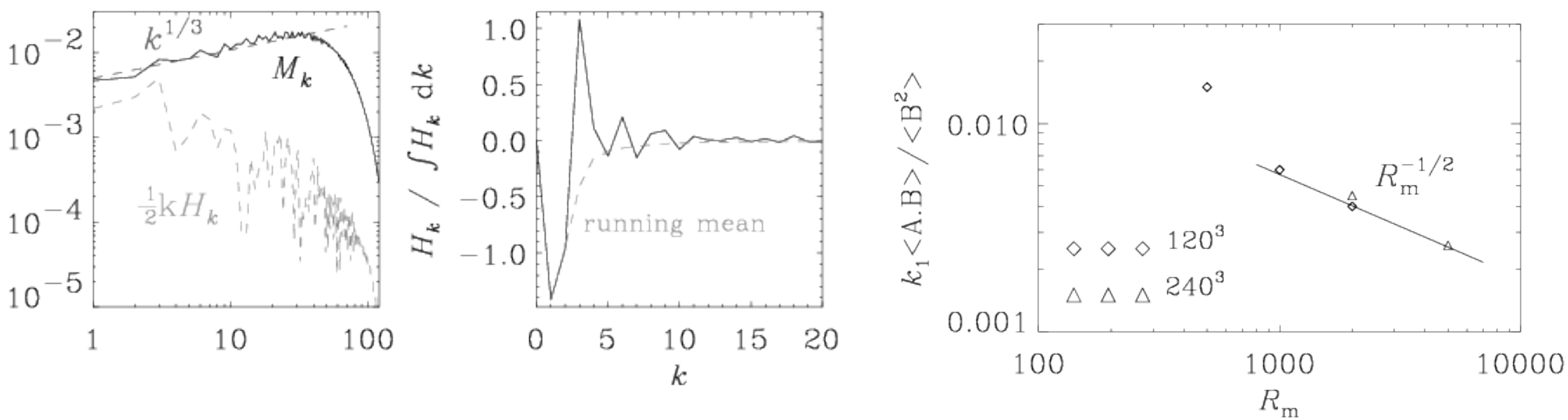
… to Galloway

… and his ABC flow dynamo simulations
… here just AB



…or rather Moffatt/Proctor ’85

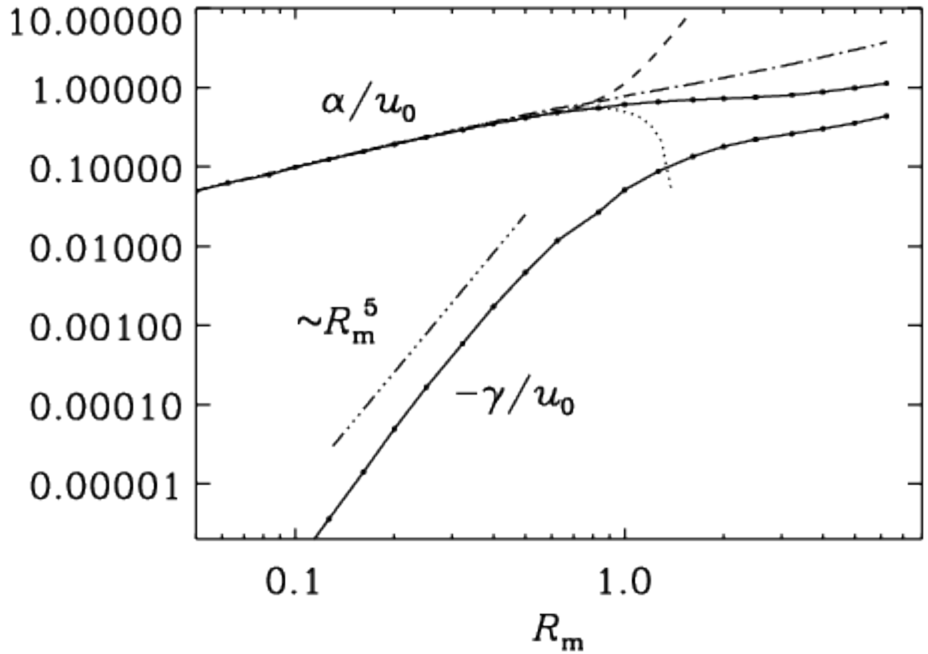
- No fast dynamo with finite <A.B>
- ABC flow dynamo: + and – at different scale
- $Rm^{-1/2}$ scaling of <A.B>/<B^2>



with Dobler & Subramanian (2002, AN)

… to Galloway-Proctor

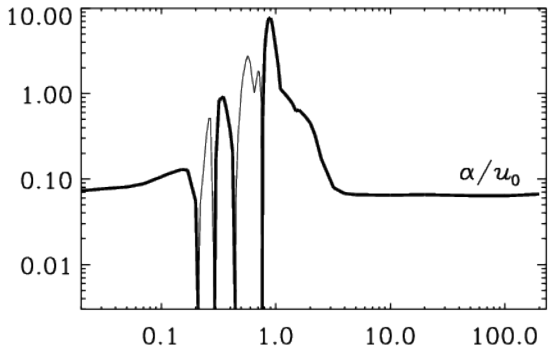
- Helical
  - Pseudo scalar
- Circularly polarized
  - Axial vector
- → proper vector
  - g effect
  - Only at 6th order

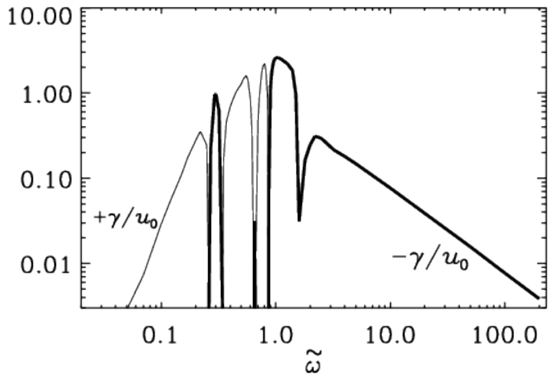


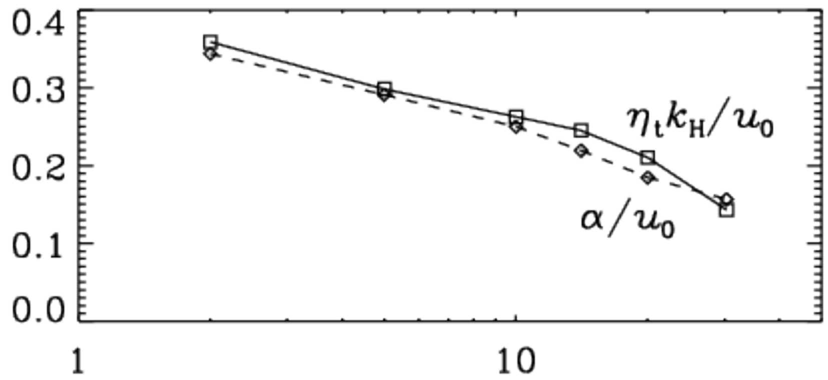
with Rädler (2009, MNRAS)

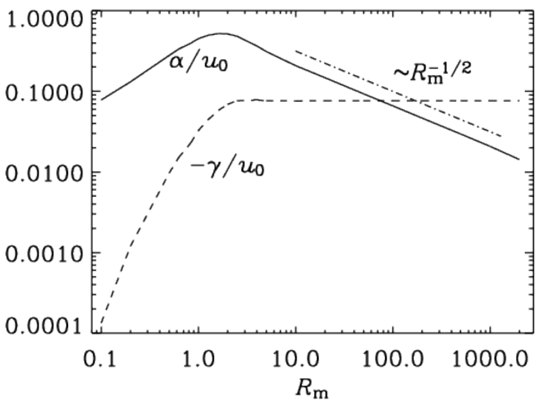
weird resonances

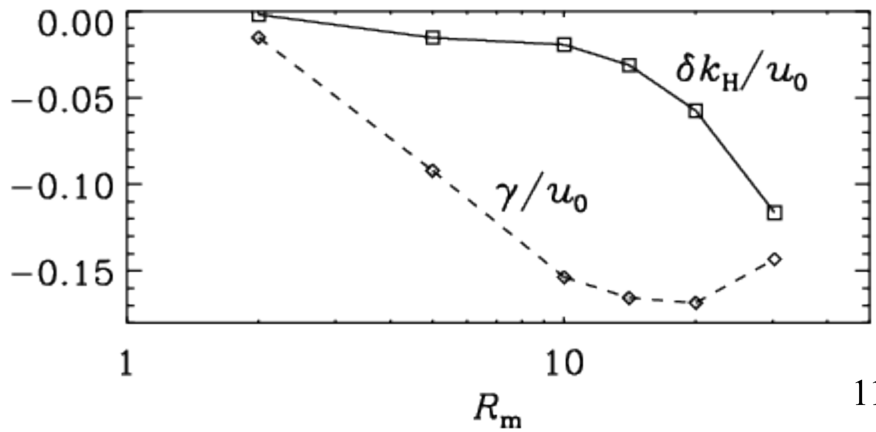
… but clear asymptotics
outside resonance range



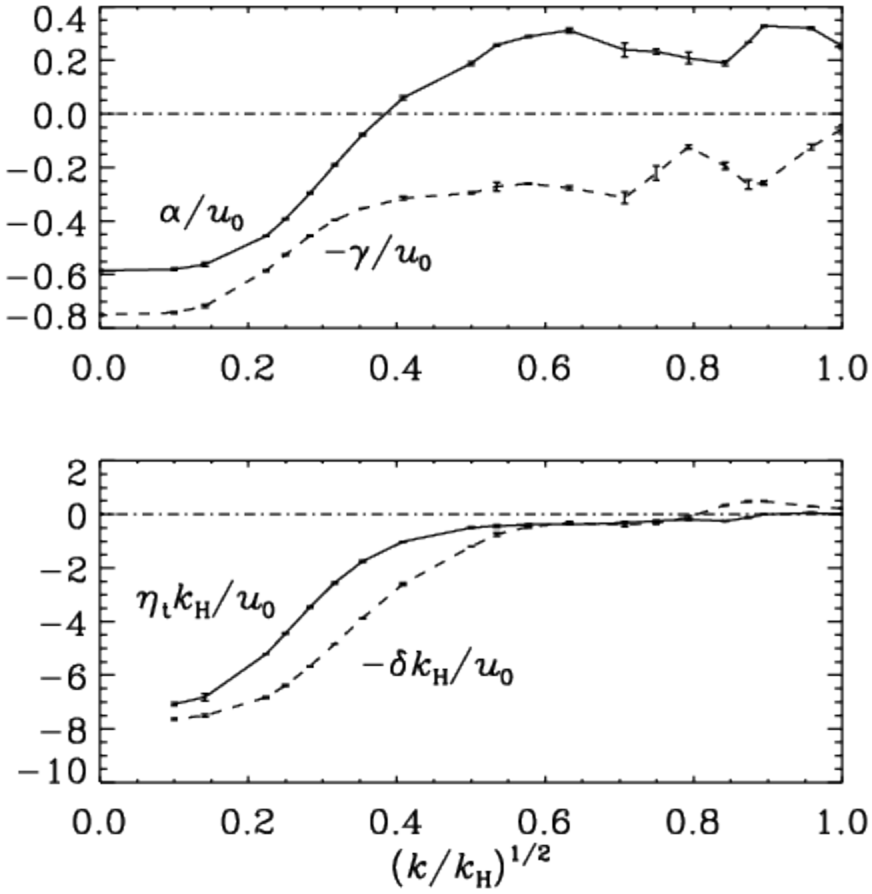






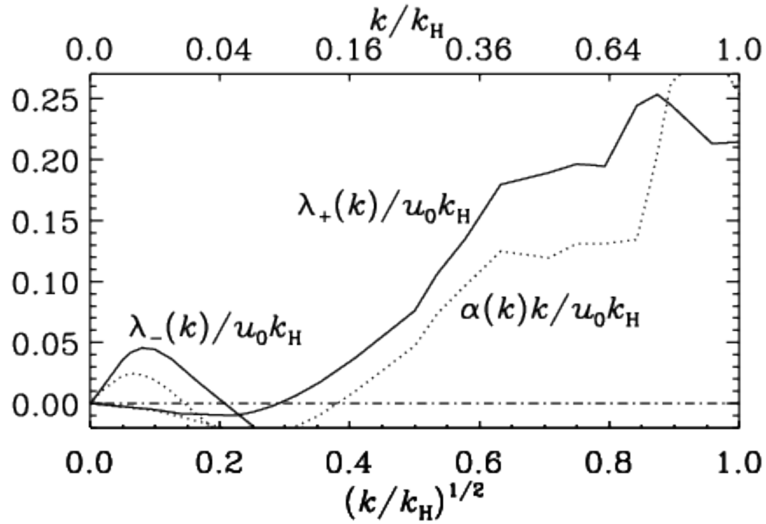


Strongly negative magn diffusivity!



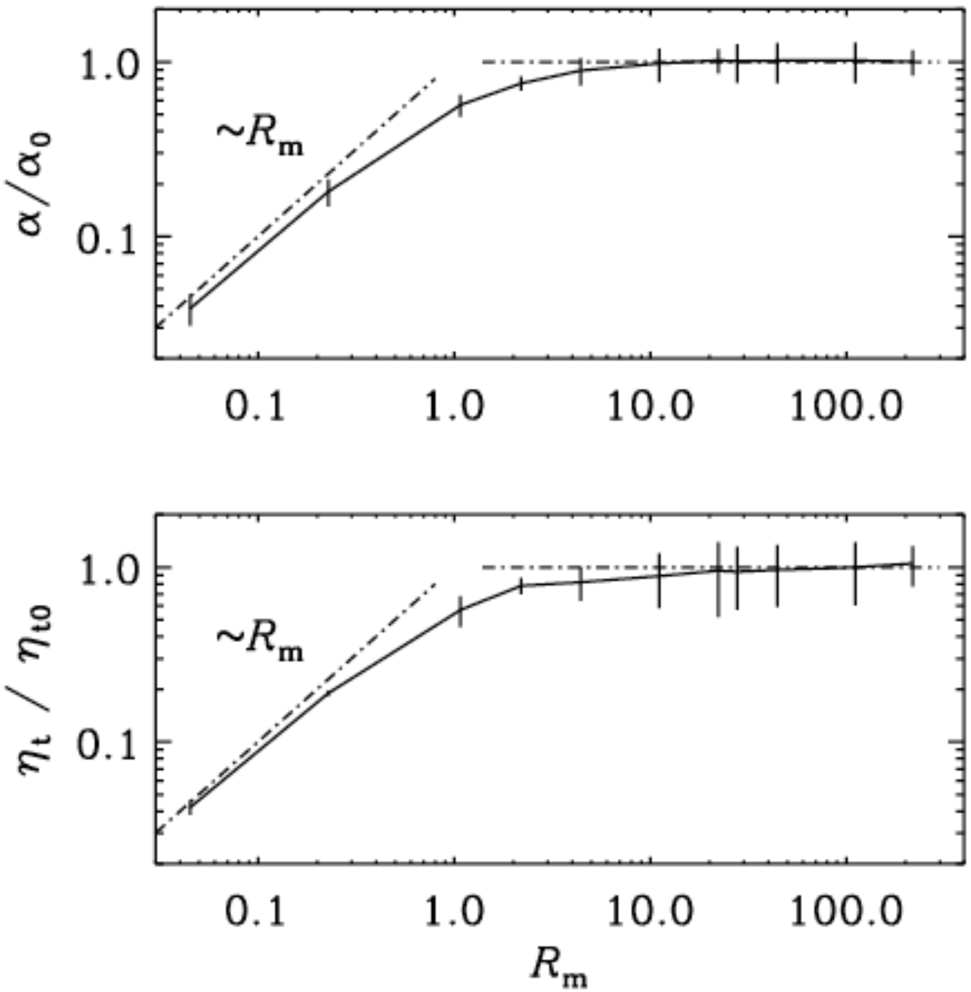
But dynamo still only because of a effect

Rm=30



What about turbulence? α and η_t

kinematic: independent of Rm (2…200)



$$\alpha_0 = -\tfrac{1}{3}\tau\langle\boldsymbol{\omega}\cdot\mathbf{u}\rangle$$

$$\eta_0 = \tfrac{1}{3}\tau\langle\mathbf{u}^2\rangle$$

$$\tau = (u_{\mathrm{rms}}k_{\mathrm{f}})^{-1}$$

$$\alpha_0 = -\tfrac{1}{3}u_{\mathrm{rms}}$$

$$\eta_0 = \tfrac{1}{3}u_{\mathrm{rms}}k_{\mathrm{f}}^{-1}$$

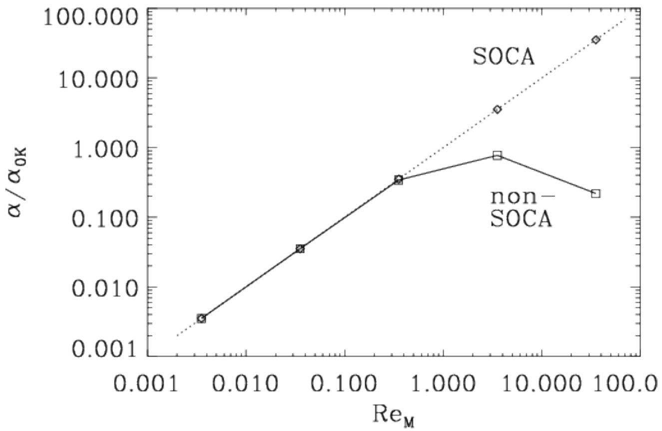
Sur et al. (2008, MNRAS)

Nonlinear test-field method

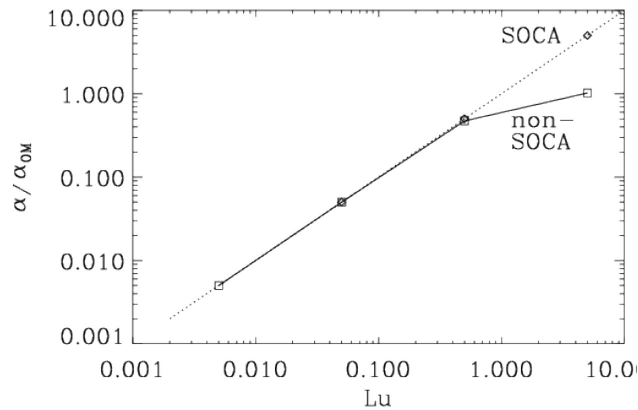
essence

$$y' = y^2, \quad y = y_N + y_L, \quad y' = y_N^2 + 2y_N y_L + y_L^2$$

$$\begin{cases} y' = y^2 \\ y'_N = y_N^2 \\ y'_L = (y_N + y)y_L \end{cases}$$



Hydromagnetically
forced Roberts flow

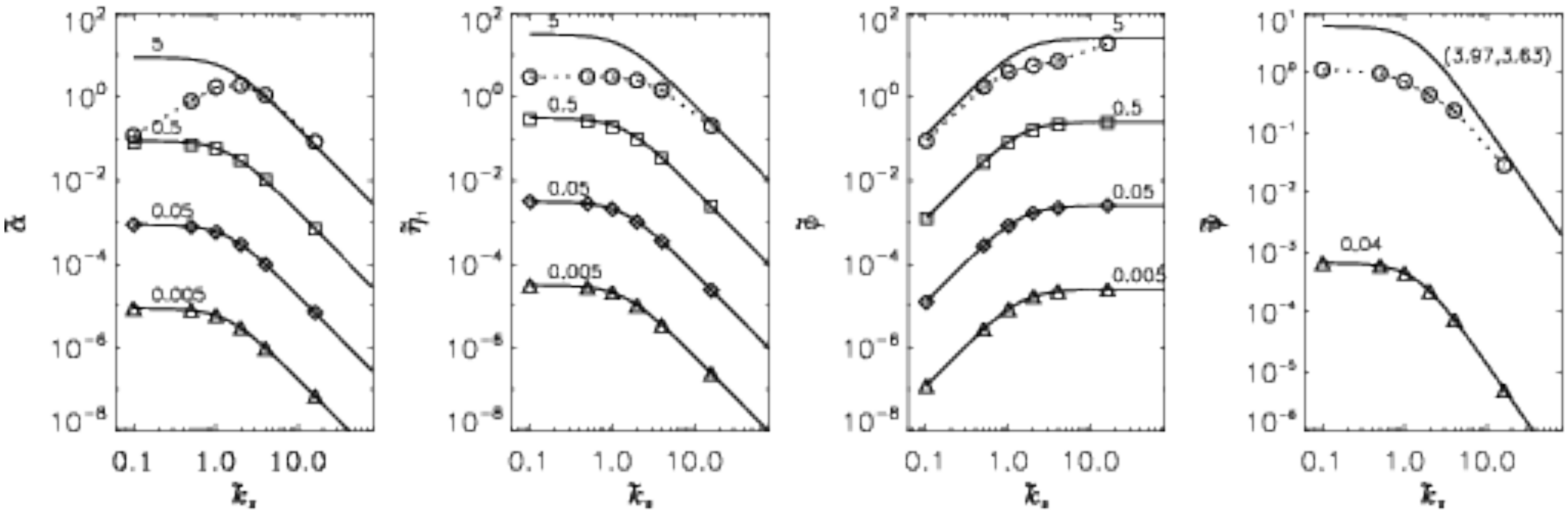


→ *effects from Lorentz force*

$$\overline{\mathbf{j}\times\mathbf{b}} = -\phi^{*}\nabla^{2}\overline{\mathbf{B}} - \psi\nabla\times\overline{\mathbf{B}}$$

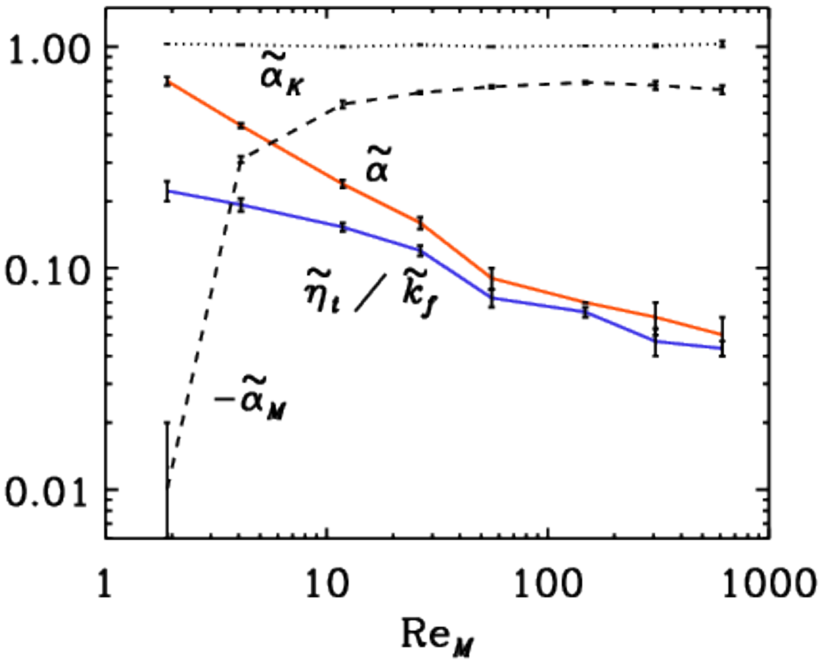
$$\overline{\mathbf{u}\times\mathbf{b}} = \quad \alpha\overline{\mathbf{B}} \; - \; \eta_{\mathrm{t}}\nabla\times\overline{\mathbf{B}}$$

Rheinhardt & B
(A&A 2010)



Hydromagnetically forced Roberts flow

QKTFM: R_m dependence for $B \sim B_{eq}$

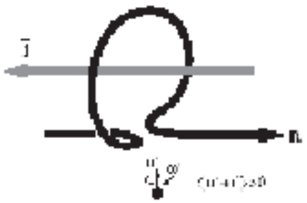


(i) l is small → consistency
(ii) a_1 and a_2 tend to cancel
(iii) making a small
(iv) h_2 small

…with Rädler, Rheinhardt, Subramanian (ApJ Lett 2008)

Run	Re_M	$\tilde{B}^2$	$\tilde{b}^2$	$\tilde{\alpha}$	$\tilde{\eta}_t$	$\tilde{\eta}$	$\tilde{\lambda}$	$-\tilde{\alpha}_2$	$-\tilde{\eta}_2$	$\tilde{\alpha}_{rms}$	$\tilde{\eta}_{rms}$	$+\tilde{\alpha}_K$	$-\tilde{\alpha}_M$	$\Delta\tilde{t}$
A	2	0.0	0.0	0.70 ± 0.03	0.67 ± 0.07	1.57	-0.14 ± 0.01	0.04 ± 0.05	-0.02 ± 0.06	0.09	0.12	1.03	0.01	150
B	4	0.9	0.4	0.44 ± 0.01	0.58 ± 0.04	0.73	0.00 ± 0.00	0.33 ± 0.02	-0.11 ± 0.03	0.10	0.21	1.02	0.31	422
C	12	1.7	0.7	0.24 ± 0.01	0.46 ± 0.02	0.25	0.00 ± 0.00	0.37 ± 0.02	-0.04 ± 0.01	0.09	0.16	1.00	0.55	601
D	30	1.9	0.8	0.16 ± 0.01	0.36 ± 0.02	0.11	-0.00 ± 0.01	0.37 ± 0.02	0.03 ± 0.03	0.07	0.14	1.02	0.62	350
E	60	2.0	0.8	0.09 ± 0.01	0.22 ± 0.02	0.05	0.00 ± 0.01	0.33 ± 0.01	0.05 ± 0.01	0.09	0.22	1.00	0.66	711
F	150	2.0	0.9	0.07 ± 0.00	0.19 ± 0.01	0.02	0.01 ± 0.01	0.24 ± 0.05	0.08 ± 0.01	0.07	0.16	1.01	0.69	225
G	300	1.8	0.9	0.06 ± 0.00	0.15 ± 0.00	0.01	0.01 ± 0.01	0.21 ± 0.02	0.05 ± 0.02	0.06	0.16	1.01	0.66	177
H	600	1.8	0.9	0.05 ± 0.01	0.13 ± 0.01	0.005	0.01 ± 0.04	0.14 ± 0.05	0.04 ± 0.01	0.05	0.10	1.03	0.64	44

CU next year: click from my home page



RädlerFest: α effect and beyond

14-18 February 2011 | **Nordita**

- List of registrants
- Overview
- Registration
  - Modify my registration

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The alpha effect is a prototype of non-diffusive turbulent transport phenomena that play important roles in understanding the formation of ordered magnetic fields from turbulent and chaotic motions. Examples include the large-scale magnetic field of the Sun, its 11 year cycle, as well as similar phenomena in other stars, accretion disks, and galaxies. Other related effects are the Lambda effect for explaining mean angular momentum transport in rotating bodies, as well as the effects of mean flows and mean magnetic fields on linear momentum transport in stars.

In recent years, this subject has attracted ever growing attention through close comparisons with laboratory and numerical experiments. The purpose of this meeting is to discuss recent progress and to highlight outstanding problems, clarify controversies, and to identify future possibilities for making progress. In this spirit, there will be ample opportunity for formal and informal discussions, in addition to contributed and invited talks.

The meeting will also provide an opportunity to celebrate Karl-Heinz' 75th birthday (although the actual date was already in May 2010).

The meeting is sponsored jointly by **Nordita** and the **Astrophysical Dynamo ERC Project** ..

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