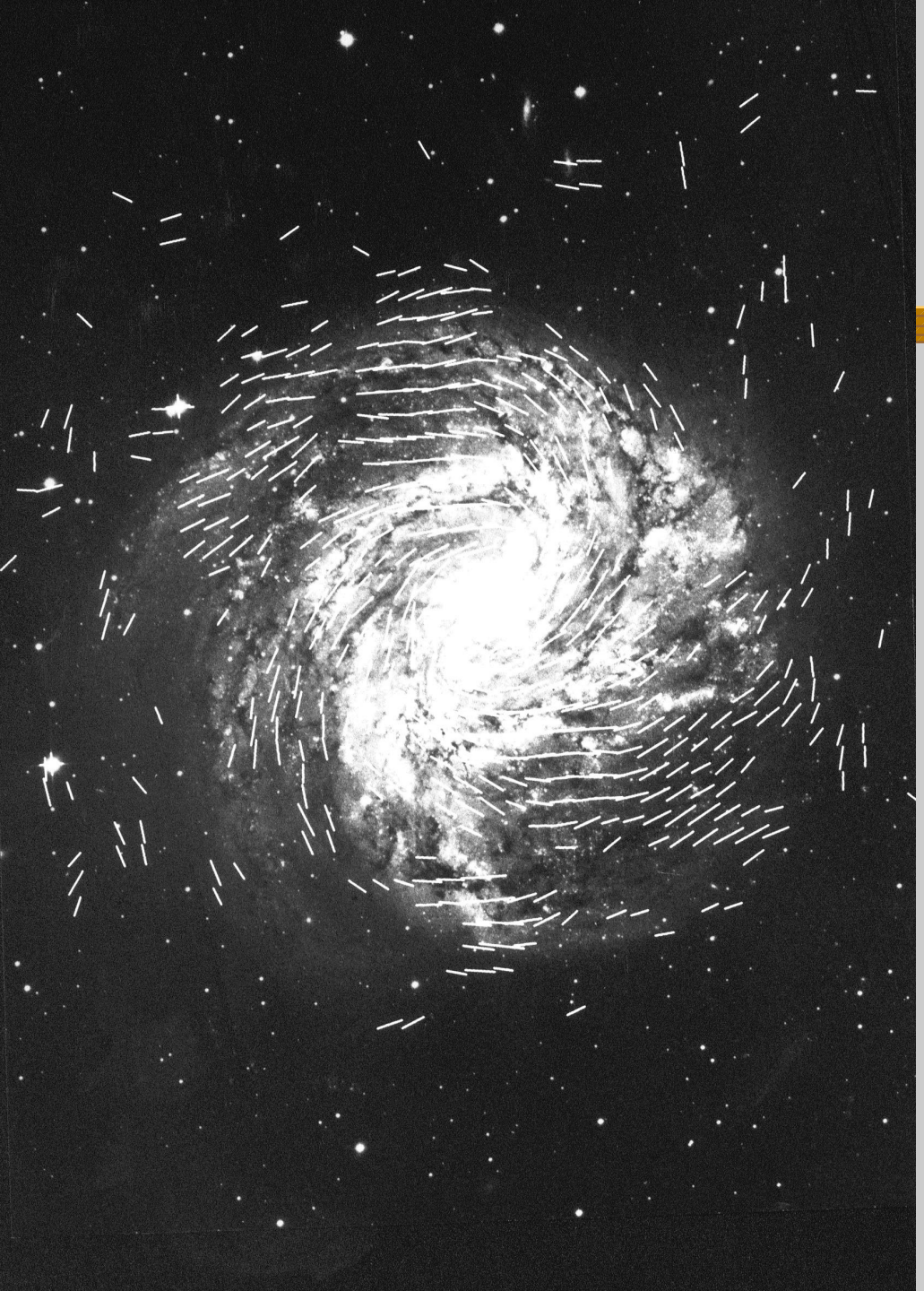
АКТУАЛЬНЫЕ ПРОБЛЕМЫ ВНЕГАЛАКТИЧЕСКОЙ АСТРОНОМИИ - XXV

Пущино, 22– 24 апреля 2008 г.

CAN ODD AND EVEN PARITY MAGNETIC FIELDS COEXIST IN DISC GALAXIES?

D.Moss, Manchester
Д.Д. Соколов, МГУ



Магнитное поле M51

Крупномасштабное поле
B около 5 μG
L около 10 kpc

b/B около 1.5

B плоскости галактики

Классические галактики
M31, M51,
NGC 6946

Галактическое динамо

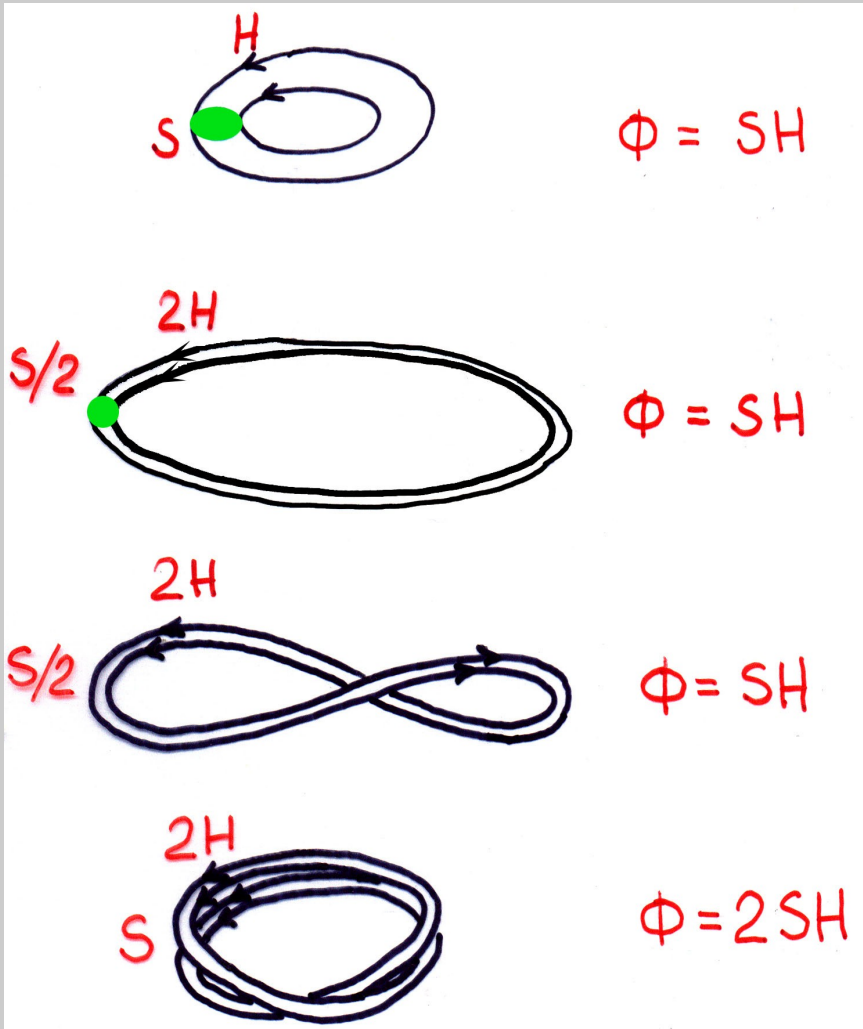
Дифф. вращение

Из полоидального - тороидальное

Спиральность

Из тороидального – полоидальное

Я.Б. Зельдович
Краков, 1972



α - effect

$$\alpha = \frac{\tau < v \; \mathrm{rot} \; v >}{3}$$

$$J = \alpha B$$

Магнитные конфигурации

- Диск – квадруполь, стационар, в диске
- Гало – диполь, осцилляции, в гало

Удается воспроизвести по-отдельности.

Можно ли воспроизвести вместе?

Трудности: диск тонкий, нужно очень много сеточных точек. В полной мере промоделировать нельзя.

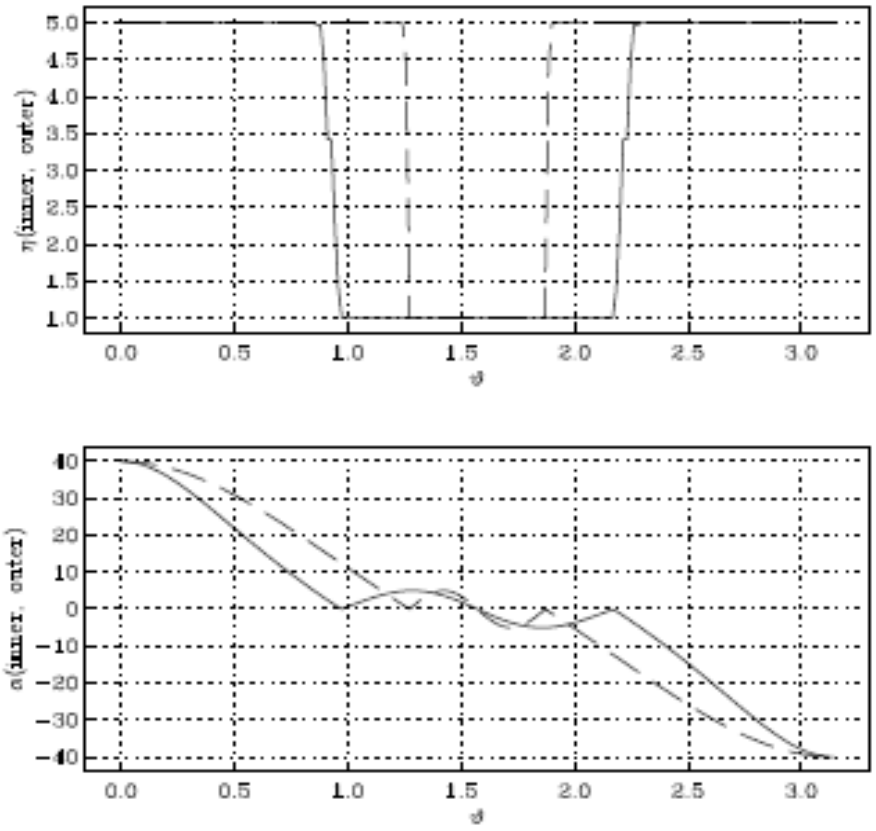


Fig. 1. Latitudinal profiles of α (lower) and η (upper) at radii $R/3$ (solid) and $2R/3$ (broken) for $R_\alpha^h = 5$, $R_\alpha^d = 40$ and $\eta_h/\eta_d = 5$.

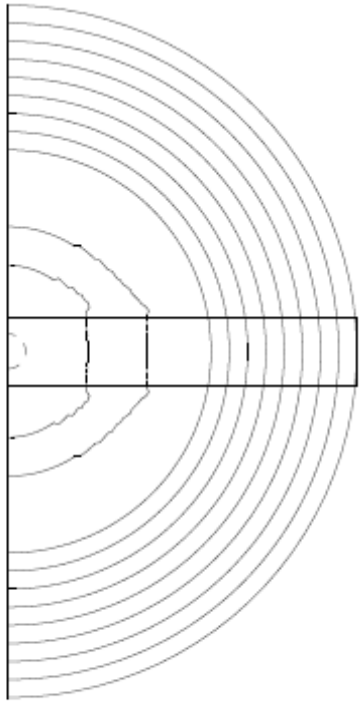


Fig. 2. Contours of angular velocity Ω. The small dashed arc represents the inner boundary of the computational domain, and the disc domain is also outlined.

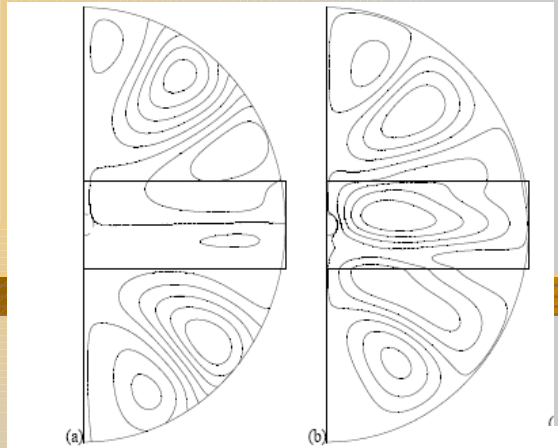
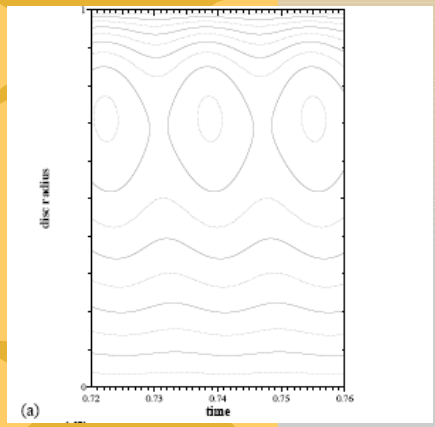
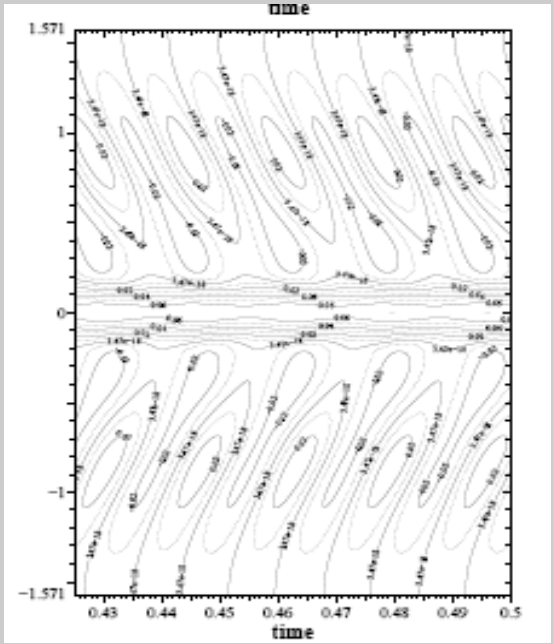


Fig. 3. Snapshot of poloidal field lines (left hand panel) and toroidal field contours (right hand panel) for the halo dominated model 135b – see Table 1.





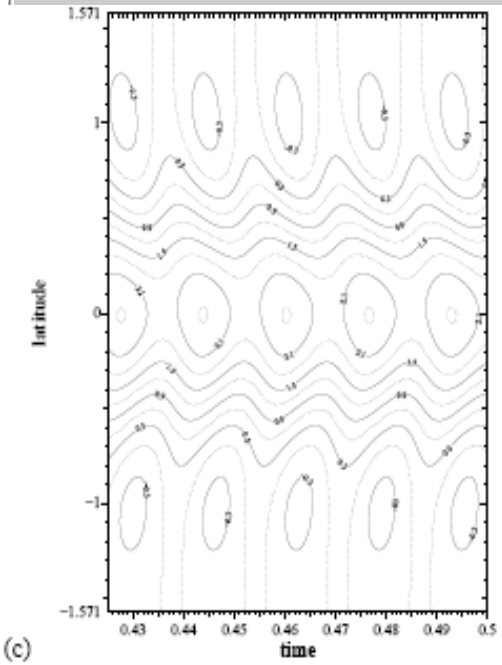


Fig. 4. Model 134b: space-time ("butterfly") diagrams for (a) the azimuthal field in the equatorial plane – the vertical axis is distance from the rotation axis; (b) the azimuthal field in the halo at distance $0.98R$ from the origin; (c) the azimuthal field at radius $0.15R$. In cases (b) and (c) the vertical axis is the angle θ.

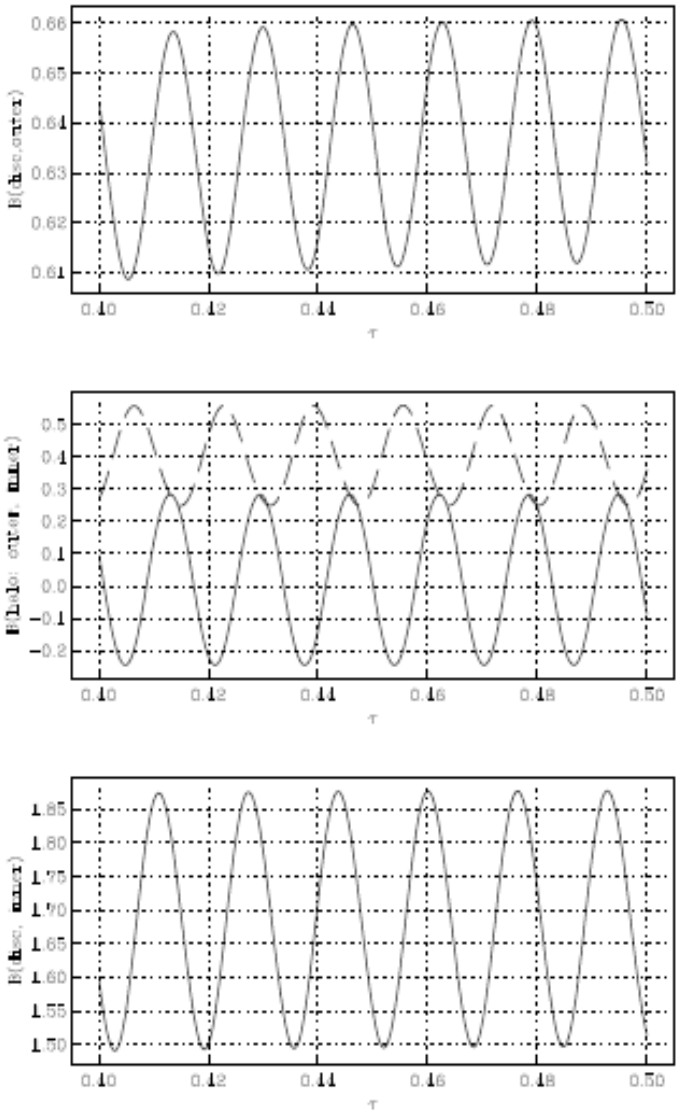


Fig. 7. Model 134b: as Fig. 5, time dependence of B_ϕ in inner and outer parts of the disc region (bottom and top panels), and (middle panel) in the inner and outer parts of the halo region (broken and continuous curves respectively).

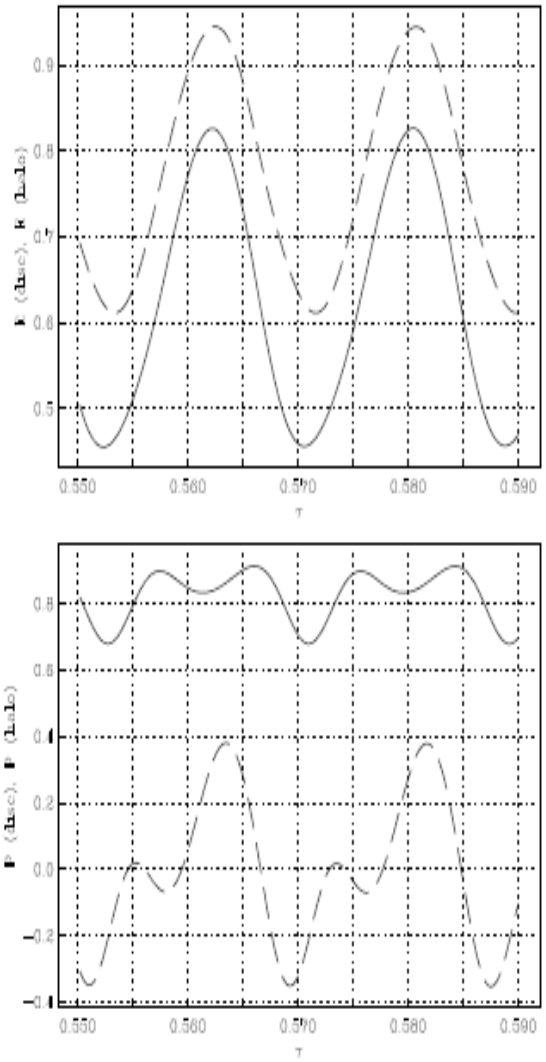


Fig. 9. Model 134b: in the lower panel, the time dependence of the parity of the disc fields (solid) and halo field (broken) curves, in the upper panel the behaviour of the corresponding magnetic energies.

Model	R_α^d	R_α^h	Solution
101	5	0	$P \rightarrow 1$, steady, disc dominated
102	0	150	osc, M(eq) outside of disc
104	3	2	steady decay
105b	3	10	steady, $P = +1$
106b	3	20	steady, $P = +1$
153b	3	25	steady, $P = +1$
154b	3	30	decay
155b	3	35	slow approach to steady $P = +1$ through oscillatory transients. Disc dominated
107b	3	40	SP in E, DP in P, $P \rightarrow -1$ slowly, halo dominated, M(eq) at large radii, little migr. at small radii
108	3	60	oscillatory in P and E
109	3	200	oscillatory in P and E
131b	5	2	$P = +1$, steady, disc dominated
132b	5	10	$P = +1$, steady, disc dominated
133b	5	20	$P = +1$, steady,mainly disc dominated, some significant B_{tor} in halo
138b	5	35	slow approach to steady $P = +1$ through oscillatory transients.
139b	5	37	DP in P, $0.993 \leq P \leq 0.995$, SP in E
134b	5	40	SP, $0.95 \leq P \leq 0.97$, disc dominated, some field in halo
135b	5	60	DP in P, $0.1 \leq P \leq 0.6$ SP in E, field mainly in halo, M(eq) in halo
136b	5	200	SP in P, $0.55 \leq P \leq 0.80$, B_{pol} in halo, some B_{tor} also in disc, M(eq)

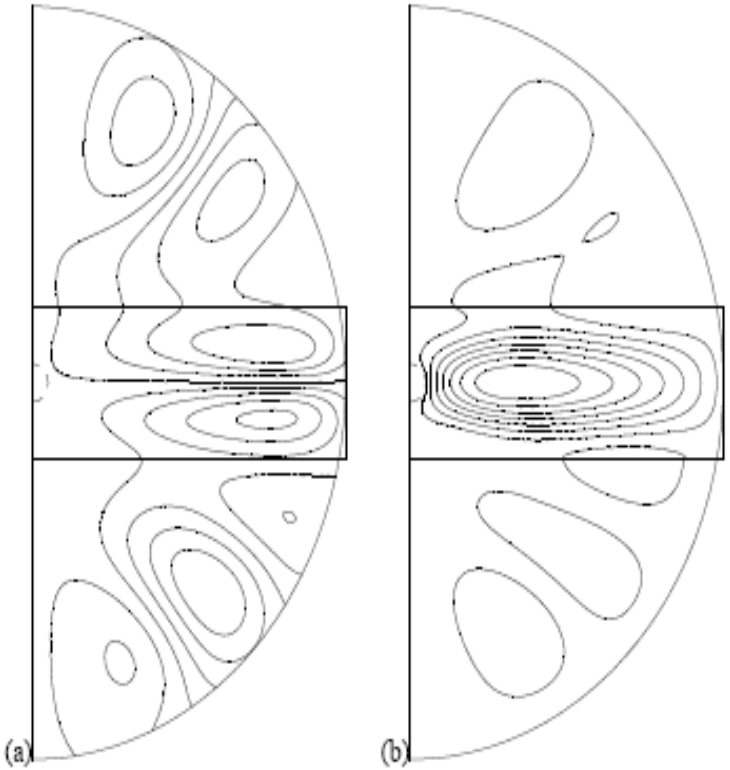


Fig. 8. Snapshot of poloidal field lines (left hand panel) and toroidal field contours (right hand panel) for the intermediate model 134b – see Table 1.

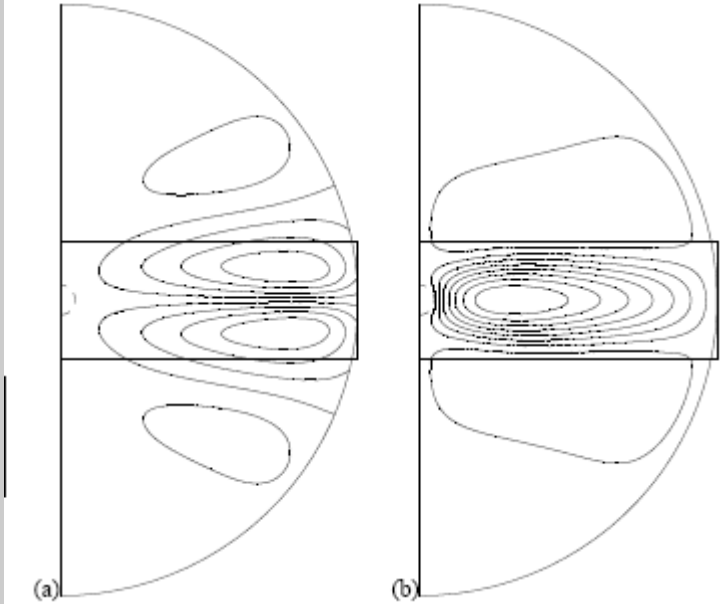


Fig. 10. Snapshot of poloidal field lines (left hand panel) and toroidal field contours (right hand panel) for the disc dominated model 133b – see Table 1.

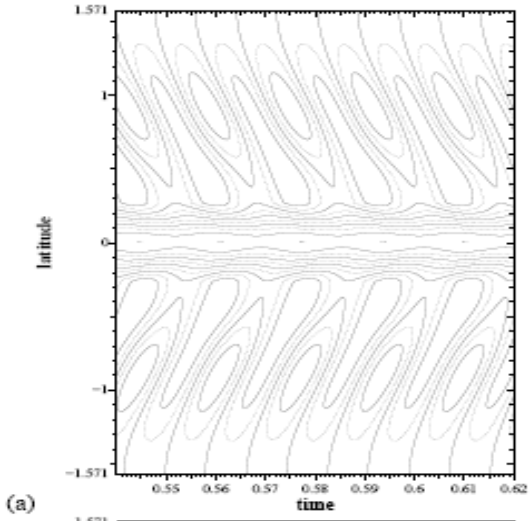


Fig. 11. Magnetic field configuration in the model 134b: a,b - latitude-time diagram for $r = 0.75$ and $r = 0.5$.

support our conjectures outlined in Sect. 1. Possibly, we should here remember the wisdom of the Russian philospher Kozma Proutkoff that "Some phenomena remain obscure for us not because of the weakness of our concepts but rather because the phenomena are beyond the scope of the concepts", and so modify our expectations concerning the magnetic confi guration in the disc.