

Database for solar flare analysis with 3D magnetic dipole models

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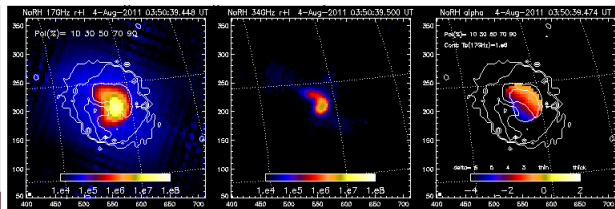
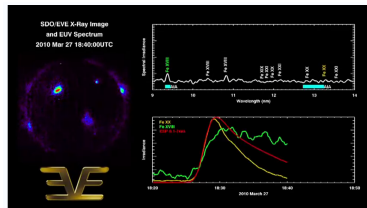
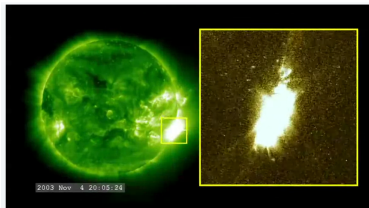
Instituto Nacional de Pesquisas Espaciais

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Motivação do trabalho



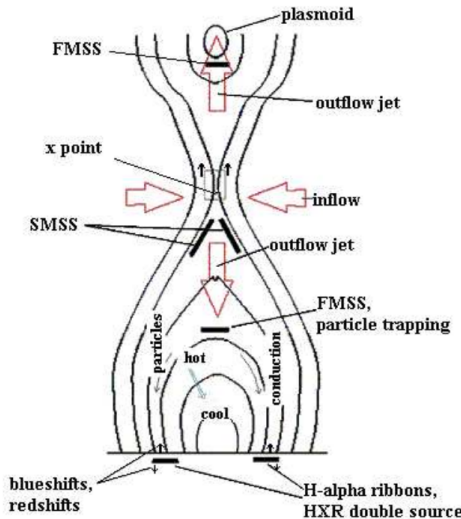
- Encontrar as condições geométricas em uma garrafa magnética que permitem reproduzir as propriedades estatísticas dos espectros observados por NoRP e a distribuição de brilho de NoRH.

Objetivos do estudo

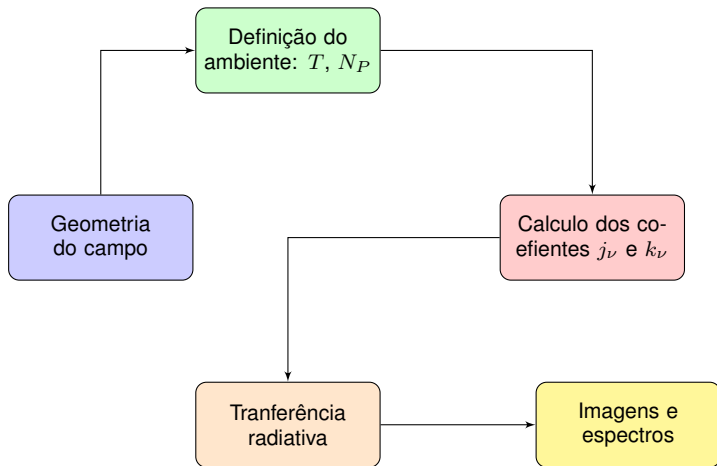
- Reconstruir a geometria das estruturas magnéticas, introduzindo maior complexidade nos arcos magnéticos ([modelo de dipolo em 3D](#)).
- Produzir um [banco de modelos](#) cujas propriedades estatísticas dos espectros observados por NoRP e a distribuição de brilho de NoRH sejam refletidas.
- Propor um método rápido de [análise das explosões solares em microondas](#) baseado no banco de modelos pre-calculados.

Explosões solares

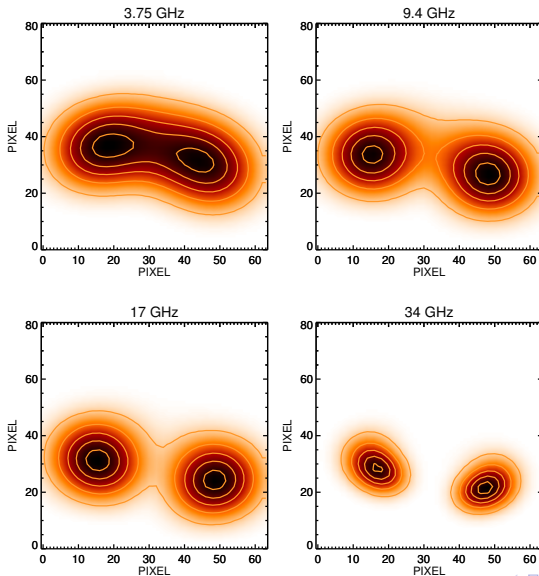
- "intenso aumento do brilho localizado sobre uma região ativa que dura de segundos a horas "
- "liberação catastrófica de energia"
- "emissão intensa e repentina da radiação causando aumento em todo espectro eletromagnético"

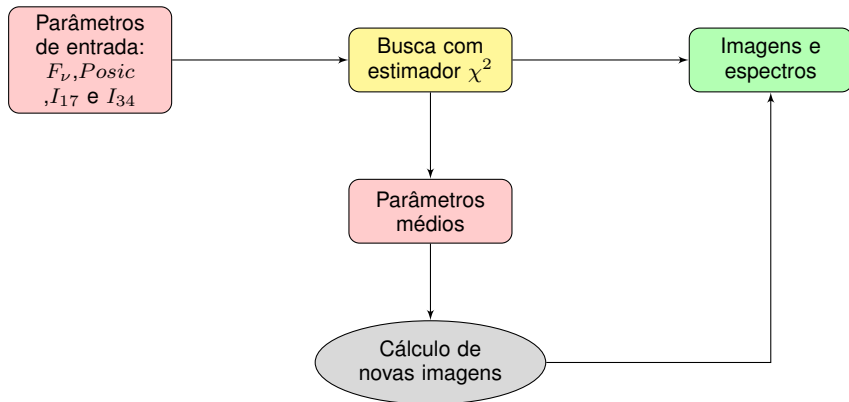


Modelo 3D



Resultado das etapas anteriores






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Following possibilities are given>

#	Index	Long	Lat	azimuth	InclIn	Assymet	chi2
1:	154:	Phl: -1.0	Lat:-17.0	Az:-66.0	Incl: 36.6	Ass: -18.3	42.85
2:	6473:	Phl: 1.0	Lat:-15.0	Az: -6.6	Incl:-24.3	Ass: -5.8	139.39
3:	1724:	Phl: -4.0	Lat:-12.0	Az:-41.0	Incl:-0.3	Ass: -8.4	186.16
4:	118:	Phl: -1.0	Lat:-17.0	Az:-53.5	Incl: 31.7	Ass:-46.7	320.23
5:	6152:	Phl: 1.0	Lat:-12.0	Az:-42.8	Incl: 12.6	Ass:-11.2	499.28
6:	1949:	Phl: -4.0	Lat:-12.0	Az: 49.0	Incl: 27.6	Ass: 17.4	551.32
7:	3390:	Phl: -6.0	Lat:-14.0	Az:-88.1	Incl: 5.7	Ass: 28.9	798.59
8:	7240:	Phl: 1.0	Lat:-18.0	Az: 88.6	Incl: 8.9	Ass:-11.7	881.88
9:	9264:	Phl: 8.0	Lat:-18.0	Az: 3.0	Incl:-24.5	Ass: 35.5	955.76
10:	5475:	Phl: 0.0	Lat:-15.0	Az: 4.6	Incl: 15.8	Ass:-19.2	1117.31
11:	5611:	Phl: 0.0	Lat:-15.0	Az: 71.0	Incl: -5.2	Ass: 35.4	1375.00
12:	3594:	Phl: -6.0	Lat:-14.0	Az: 85.7	Incl: -5.1	Ass: -43.3	1400.98
13:	2153:	Phl: -4.0	Lat:-19.0	Az:-54.8	Incl:-34.5	Ass: -16.5	1816.05
14:	5623:	Phl: 0.0	Lat:-15.0	Az: 77.5	Incl: 14.4	Ass: 45.4	1937.37
15:	7986:	Phl: 3.0	Lat:-10.0	Az: 67.8	Incl:-39.5	Ass: -31.3	1977.51
16:	1819:	Phl: -4.0	Lat:-12.0	Az:-89.3	Incl:-15.8	Ass: -23.7	2127.40
17:	5493:	Phl: 0.0	Lat:-15.0	Az: 15.2	Incl: 20.1	Ass:-29.2	2187.41
18:	8976:	Phl: 8.0	Lat:-18.0	Az:-28.1	Incl:-36.4	Ass: -31.9	2190.54
19:	9755:	Phl: -8.0	Lat:-19.0	Az:-48.4	Incl:-15.0	Ass: -0.1	2311.87
20:	3338:	Phl: -6.0	Lat:-14.0	Az:-66.7	Incl:-18.0	Ass: 8.9	2443.94

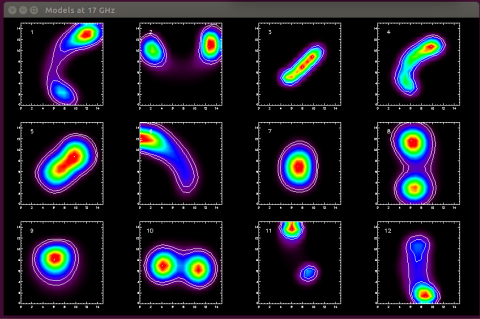
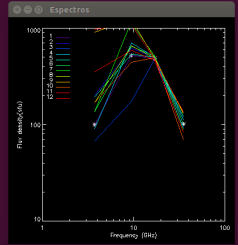
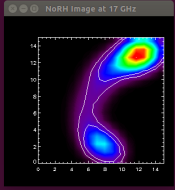
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% Program caused arithmetic error: Floating illegal operand
IDL> restore,'phenotype.sav'
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IDL> print,phenot.par
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1.	80193	3.85481	2.15166e+07	1.00000e+08	1.00000e+12	-18.3099
1.	38715	4.39808	1.58425e+07	1.00000e+08	1.00000e+11	-5.83290
1.	69836	4.23534	9.90064e+07	1.00000e+08	1.00000e+12	-8.38419
1.	87326	3.40589	1.55849e+07	1.00000e+08	1.00000e+12	-46.7123
1.	69425	3.99016	1.88202e+06	1.00000e+08	1.00000e+12	-11.2378
1.	03989	4.00790	1.47360e+07	1.00000e+08	1.00000e+12	17.3514
1.	96643	3.84792	1.67200e+07	1.00000e+08	1.00000e+10	28.9485
0.	490759	3.90157	3.66709e+07	1.00000e+08	1.00000e+11	-11.6984
1.	93122	3.57970	8.51065e+07	1.00000e+08	1.00000e+10	35.4593
0.	987798	3.54109	1.28704e+06	1.00000e+08	1.00000e+10	-19.2307
0.	541020	4.07145	9.10720e+06	1.00000e+08	1.00000e+10	35.4488

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0.	00057442	0.0516930	0.0323610	36.6159	1466.81
0.	0139548	0.0549367	0.0369829	-24.3450	2438.86
0.	00301425	0.0517505	0.0532748	-8.26782	1391.21
0.	00444993	0.0375589	0.0501472	31.7121	1006.38
0.	0178276	0.0316734	0.0254558	12.5730	3628.55
0.	00942482	0.0521071	0.0220461	27.6925	1383.21
0.	0110806	0.0455856	0.0369083	5.70676	3270.95
0.	0187677	0.0357633	0.0263379	8.88685	2370.72
0.	0186840	0.0344148	0.0241260	-24.5228	911.558
0.	0131157	0.0252404	0.0236370	15.8257	3152.50
0.	0172449	0.0570025	0.0446790	-5.18350	1672.96



Cerca de 56% da amostra apresentaram resultados satisfatórios. Isto é, mais de 50% dos parâmetros de cada simulação são bem reproduzidos e os restantes parâmetros possuem erros abaixo de 10%.

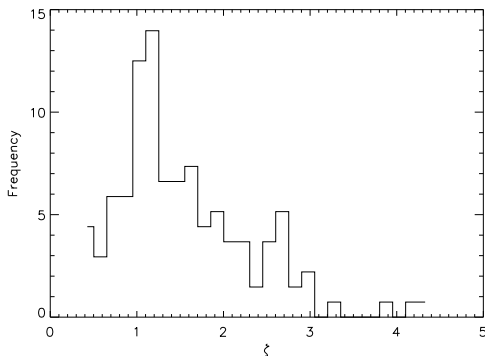


Figura : Distribuição do *erro total* ζ .

$$\chi^2 = \sum \frac{1}{\sigma_{\psi_{Obs_i}}^2} (\psi_{Mod_i} - \psi_{Obs_i})^2 \quad (1)$$

$$\zeta = \sum_{i=1}^{10} \left(\frac{|Par_i^{Sim} - Par_i^{Res}|}{Par_i^{max} - Par_i^{min}} \right) \quad (2)$$

Avaliamos os seguintes casos:

- Simulações $\zeta < 1.2$
- Simulações $\zeta \sim 1.2$
- Simulações $\zeta > 1.2$

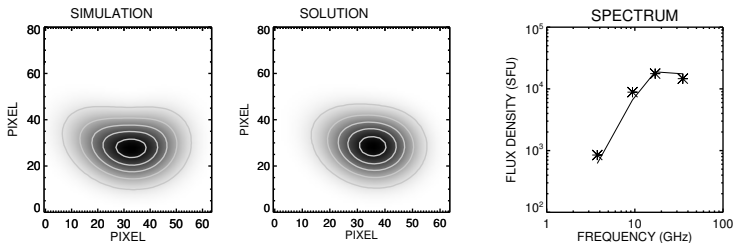


Tabela : ζ no pico de distribuição.

No.	Parameter	Simulation	Solution	Error
1	ie	1.900	1.900	0.000
2	δ	1.850	2.169	0.093
3	Asy	0.000	0.500	0.048
4	Ne	1.5e+06	6.3e+06	0.050
5	Az	0.000	15.00	0.166
6	R	0.008	0.010	0.11 1
7	F_s	0.040	0.050	0.192
8	H	0.020	0.020	0.000
9	In	-20.00	-20.00	0.000
10	B	1438.5	1693.4	0.094
	ζ			1.207

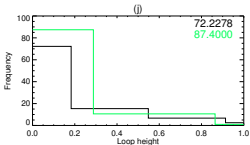
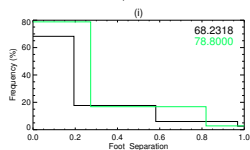
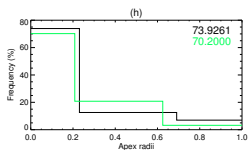
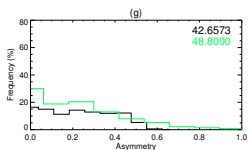
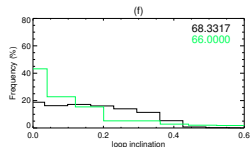
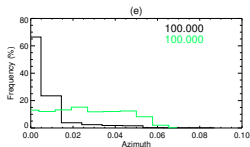
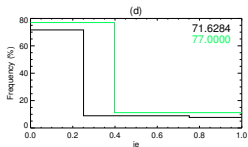
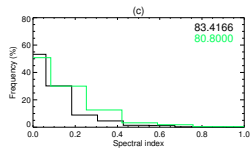
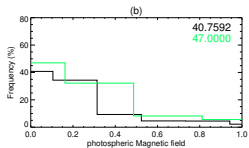
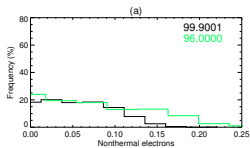
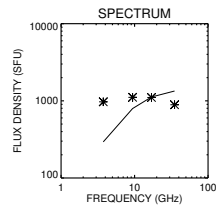
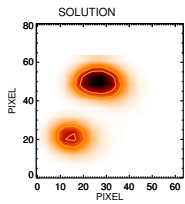
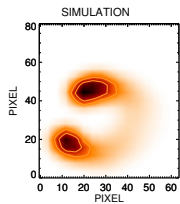
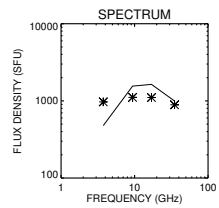
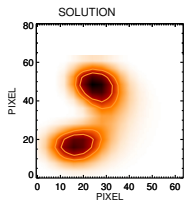
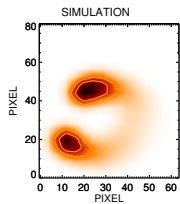
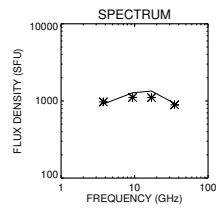
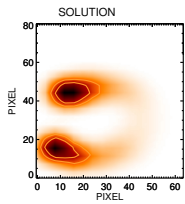
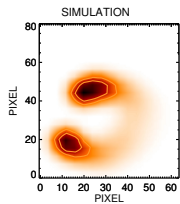
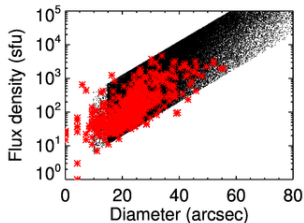
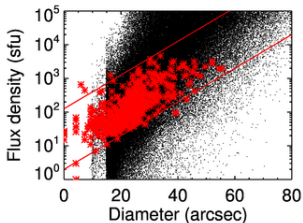
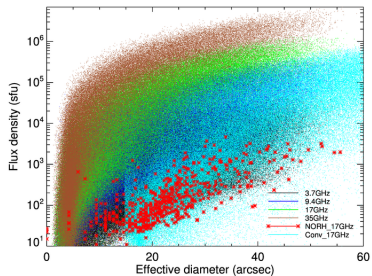
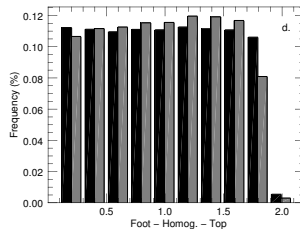
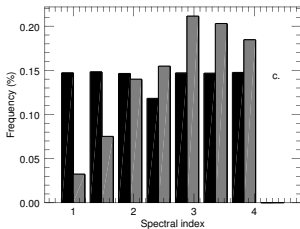
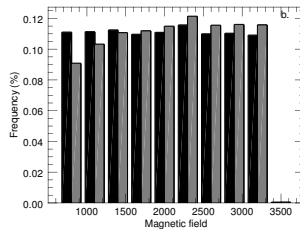
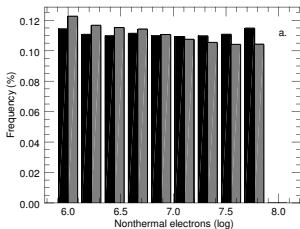


Tabela : Parâmetros da simulação e respectivas soluções ordenadas pelo χ^2 .

Parameter	ie (1)	δ (2)	$N_{\text{nth}}(\log)$ (3)	As (4)	Az (5)
A	1.37730	2.42539	6.38534	16.5031	75.6650
1	1.12157	2.14750	6.38453	-13.0776	74.2153
2	1.55427	4.07621	7.98785	-44.4395	71.9480
3	0.261389	3.86377	7.92693	47.7276	73.9229
4	0.735435	2.99990	6.32246	-38.7356	77.7328
Média	1.04766	2.44599	6.51370	-11.6934	74.7544
R_{Arc} (6)	F_{sep} (7)	H_{Arc} (8)	Inc (9)	B (10)	χ^2 (11)
0.0125987	0.0241344	0.0502481	36.3673	1505.44	–
0.00908336	0.0211555	0.0454603	26.2882	1084.96	34.2
0.0167552	0.0356139	0.0344781	-3.63393	1610.49	35.1
0.0155357	0.0318049	0.0349373	16.0901	1745.49	42.2
0.0118049	0.0301428	0.0465737	-8.78041	2380.58	42.7
0.0100789	0.0247609	0.0446416	18.2583	1450.04	–







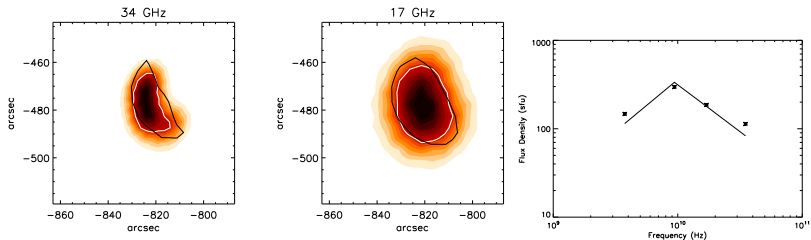


Tabela : Melhor representação da solução do banco.

Parameter	ie	δ	N_{nth} (log)	As (Deg)	Az (Deg)
Mean	1.91	3.12	6.72024	5.65	44.00
Solution	1.94	2.49	6.00277	1.00	-80.60
	R_{Arc} ($\times 10^9$ cm)	F_{sep} ($\times 10^9$ cm)	H_{Arc} ($\times 10^9$ cm)	Inc (Deg)	B (G)
Mean	0.58	2.20	2.97	4.33	2231
Solution	0.27	2.51	1.74	0.00	2297

"A ciência nunca resolve um problema sem criar pelo menos outros dez".

GEORGE BERNARD SHAW

See you tomorrow at 2pm!!

Thanks!!