

The solar differential rotation in the 18th century

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Data base

- - 1000 solar observations by Johann Caspar Staudacher in 1749-1799
 - We have spot distributions, dates and times
 - Can we measure the differential rotation?





- Ambiguous orientations of the solar disk
- Observations are only 17h apart





Data base

- Orientation of drawings is unknown
- Pairs of drawings are used to find
 - The orientations
 - The spot positions
 - The differential rotation parameter





- Another example
- It's not always obvious...







- We know what to expect: $\Omega = \Omega_{
 m eq} + \delta\Omega \sin^2 b$ perhaps plus higher term
- We also know that sunspots are fairly stationary over time
- Good knowledge of the model is a perfect case of using Bayesian inference





- Do not touch the data!
- Compute what would have been observed, given your model and compare with data:

$$\begin{split} \Lambda(x_j, y_j; \lambda_j, b_j, \delta\Omega, \Delta t) &= \\ \prod_{j=1}^{n_i} \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\left(\frac{\left[x_j - f_x(\lambda_j, b_j, \delta\Omega, \Delta t)\right]^2}{2\sigma^2} + \frac{\left[y_j - f_y(\lambda_j, b_j, \delta\Omega, \Delta t)\right]^2}{2\sigma^2}\right)\right], \end{split}$$



- Explore then entire parameter space for the probability to have produced the data
- Do this with Monte Carlo Markov chains

Spots	Measurements	Parameters
2	8	8
3	12	10
4	16	12
5	20	14
6	24	16
7	28	18
•••	•••	
20	80	44







• Split the period into two and see what happens



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. #≠+ ++ Differential rotation in dynamo AIP



Include backreaction on generation of diff. rotation

Get maximum

diff. rot after

Küker, Arlt, Rüdiger

(1999)



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- Solar observations of 250 years ago can reproduce the differential rotation of the Sun
- Slight tendency of higher differential rotation just after the Maunder minimum
- Note the enormous potential in historical observations

