Why are coronal holes indistinguishable from the quiet Sun in transition region radiation?

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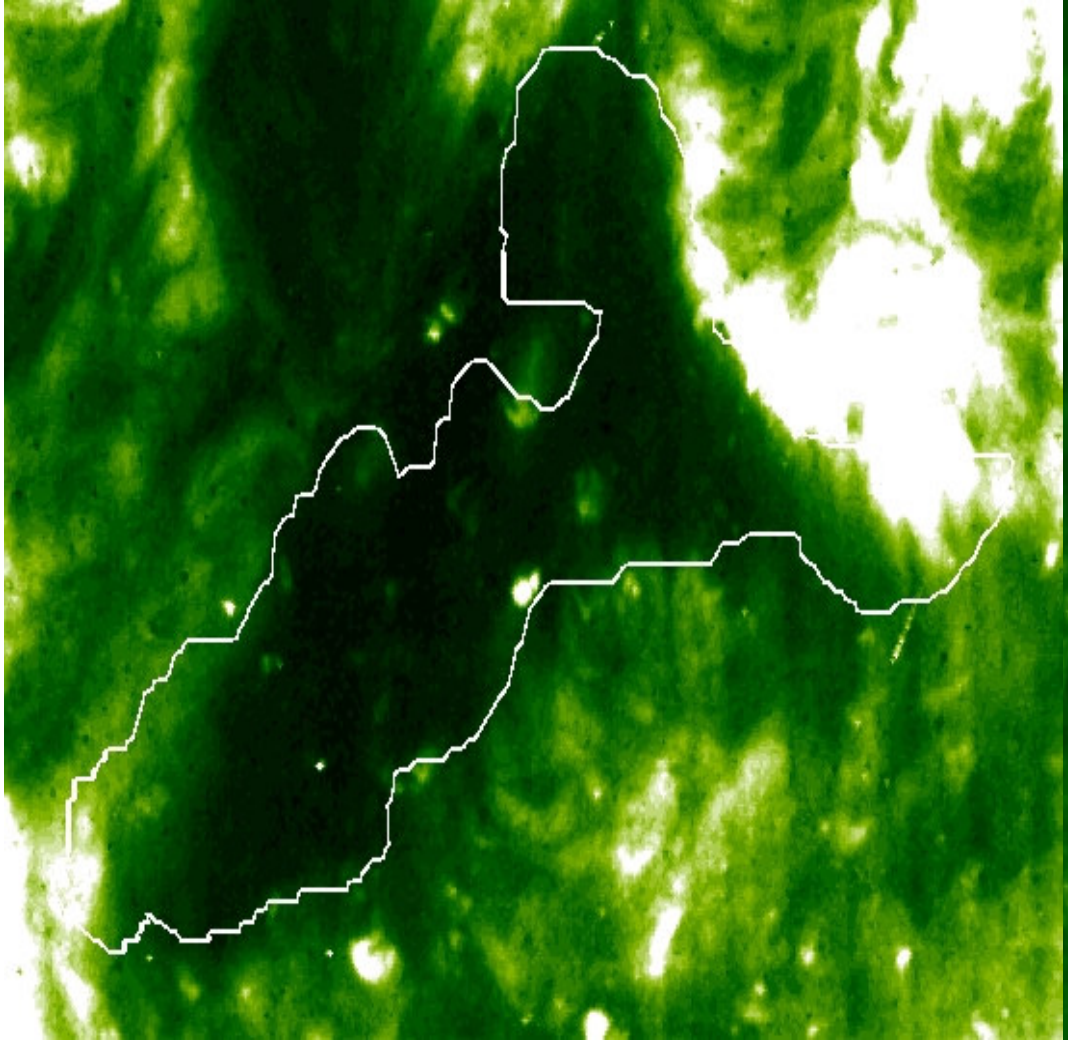
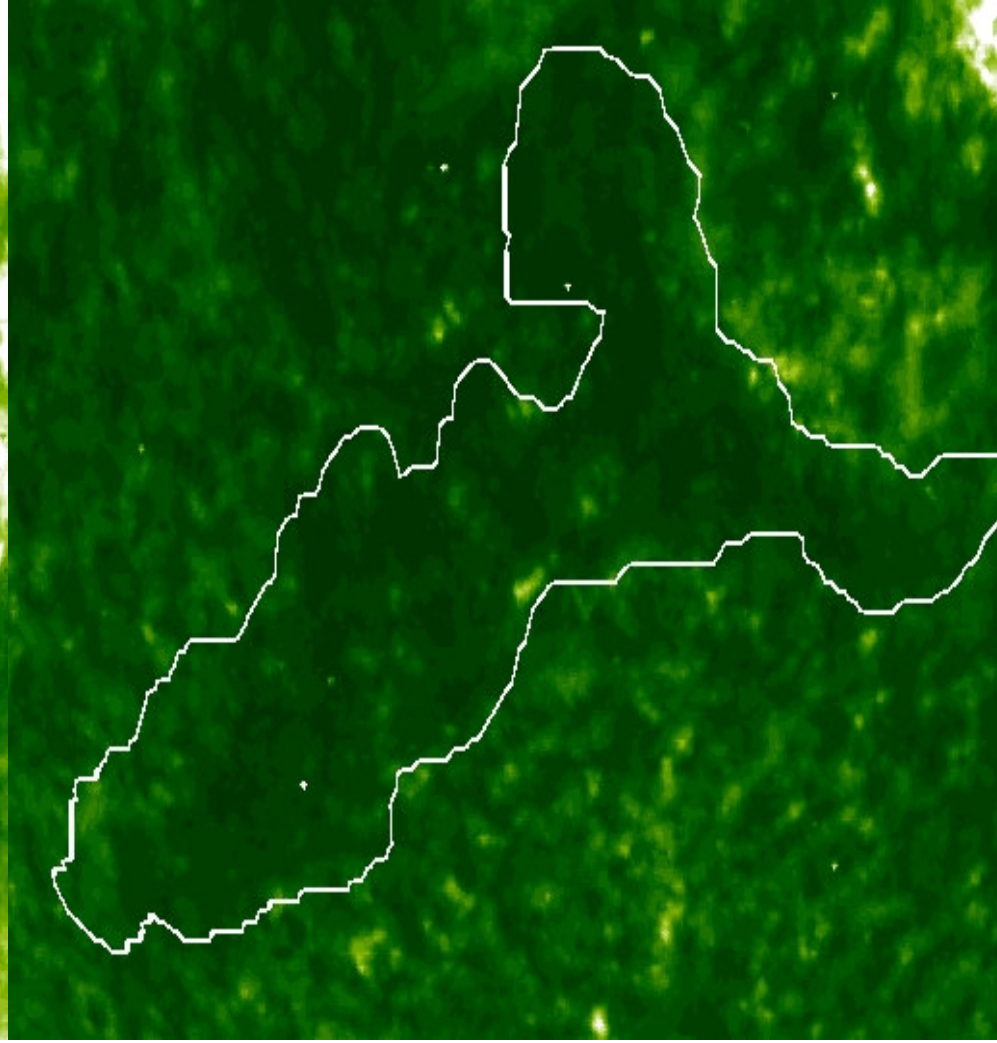
- Outline the problem
- Extrapolate the 3D magnetic field
- Loop statistics in coronal holes and the quiet Sun
- Temperature distribution and consequences
- Conclusion



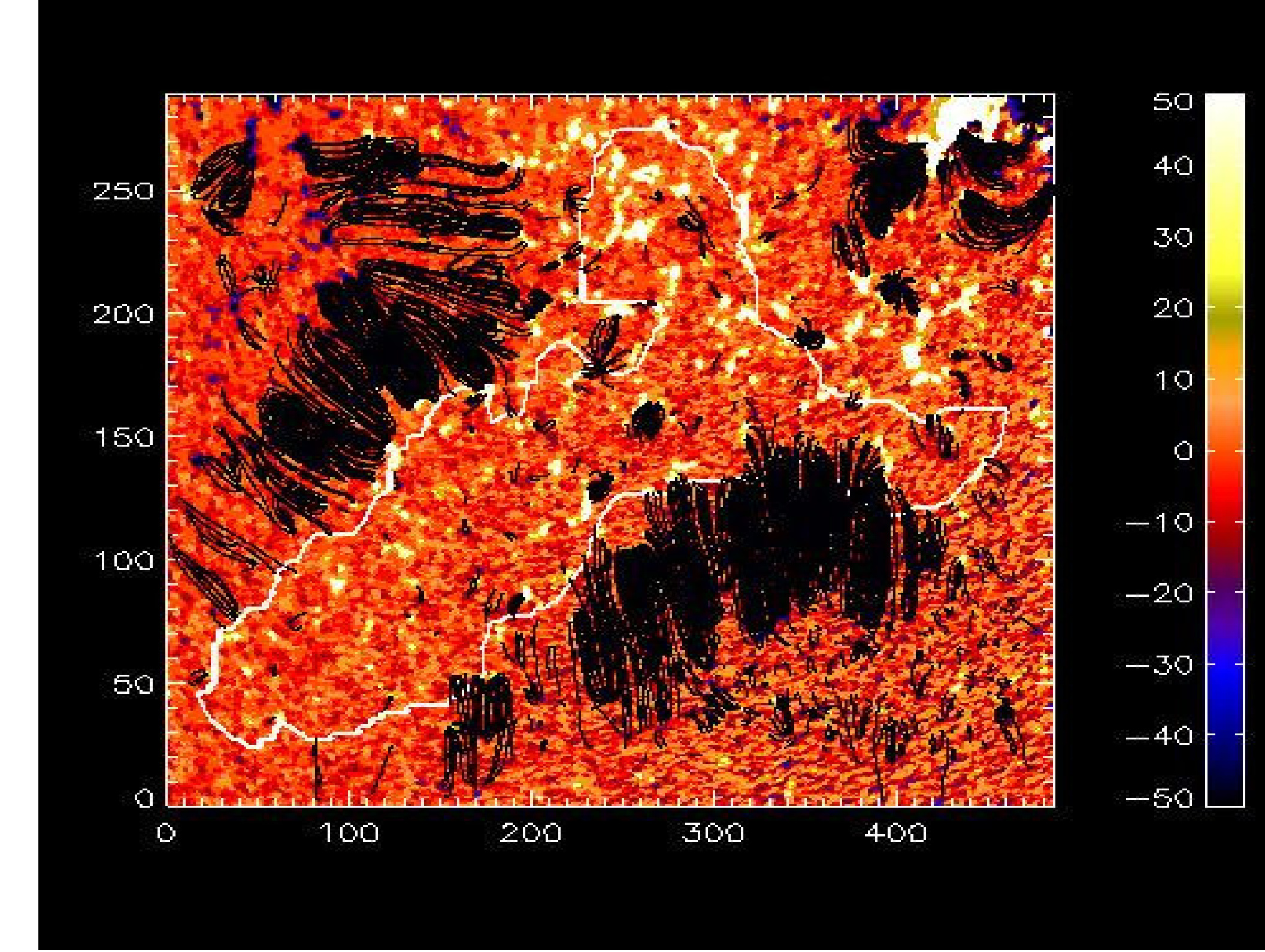
EIT 195 Fe XII
Formation temperature
1.5 million K



EIT 304 He II
Formation temperature
60,000-80,000 K

How to obtain magnetic loops?

- Measure B-field on photosphere (SOHO/MDI)
- Compute potential 3D magnetic field with Greens function method.
- Calculate magnetic field lines with 4th order Runge-Kutta field line tracer on a grid with MDI resolution (1.4 Mm)


250
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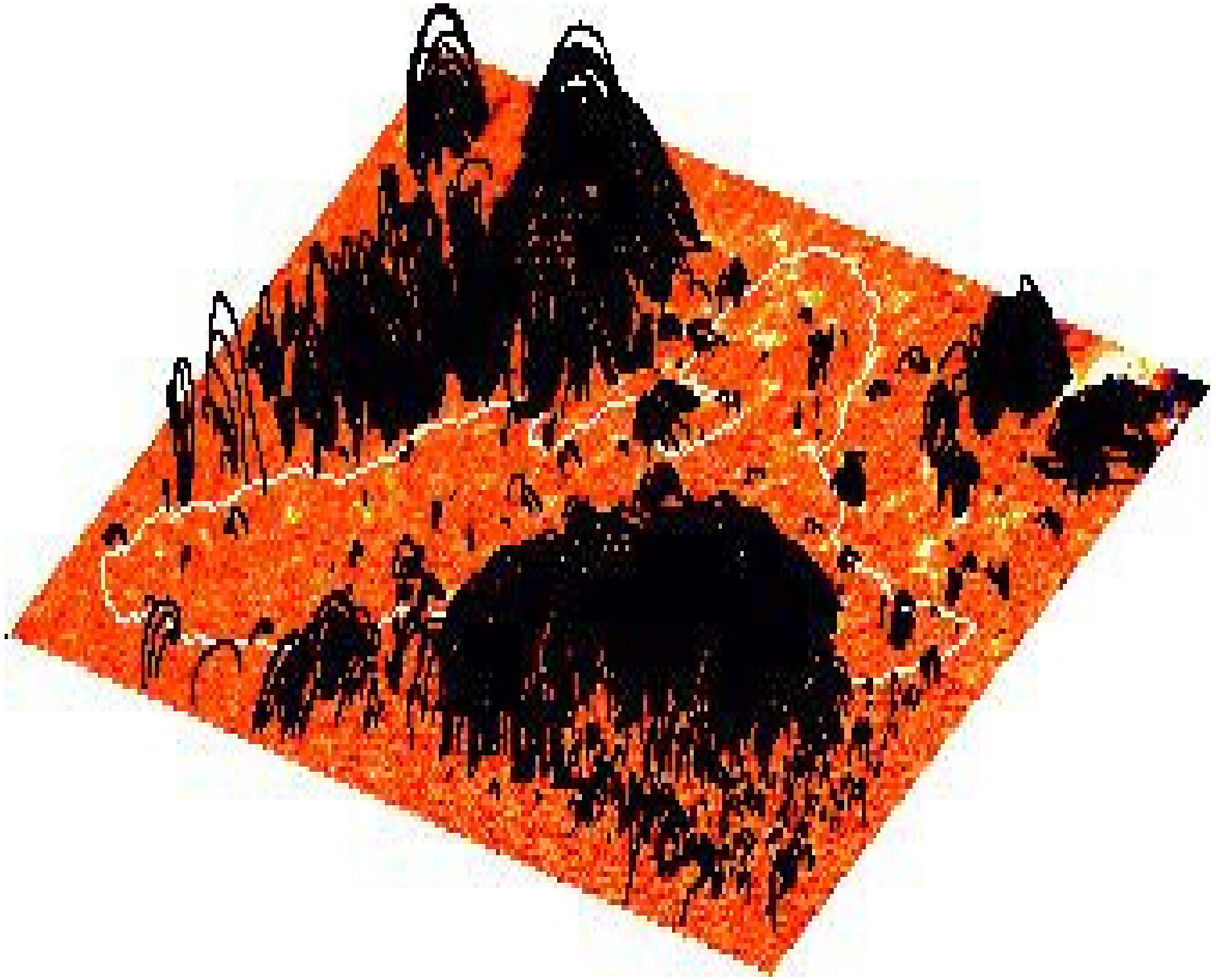
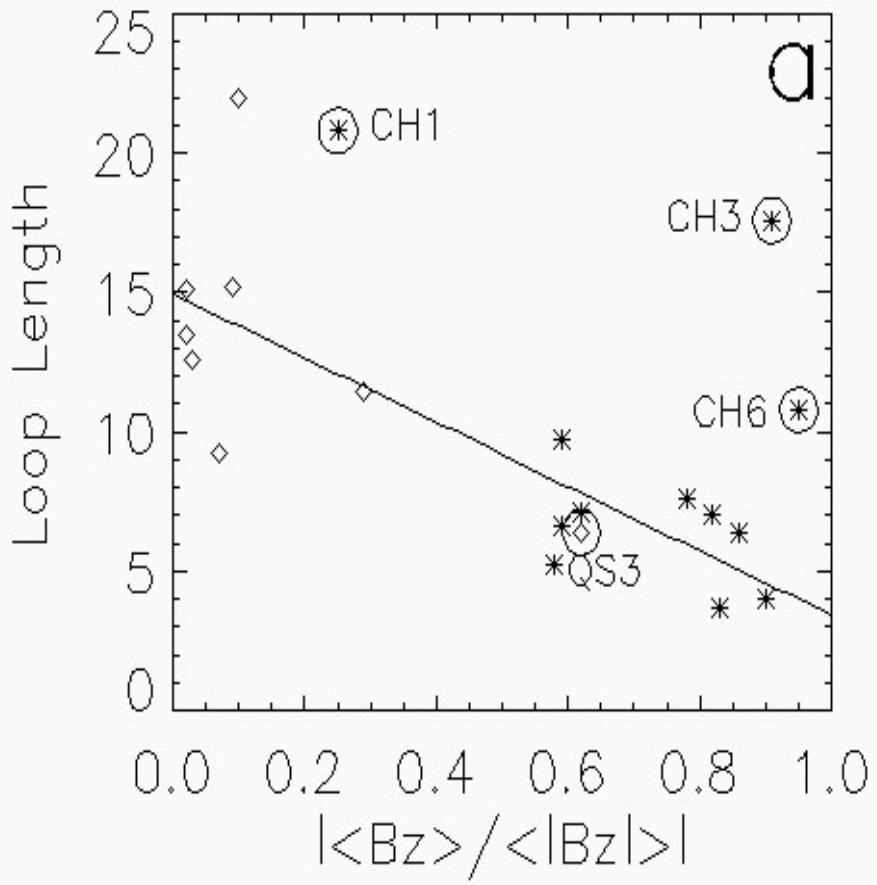


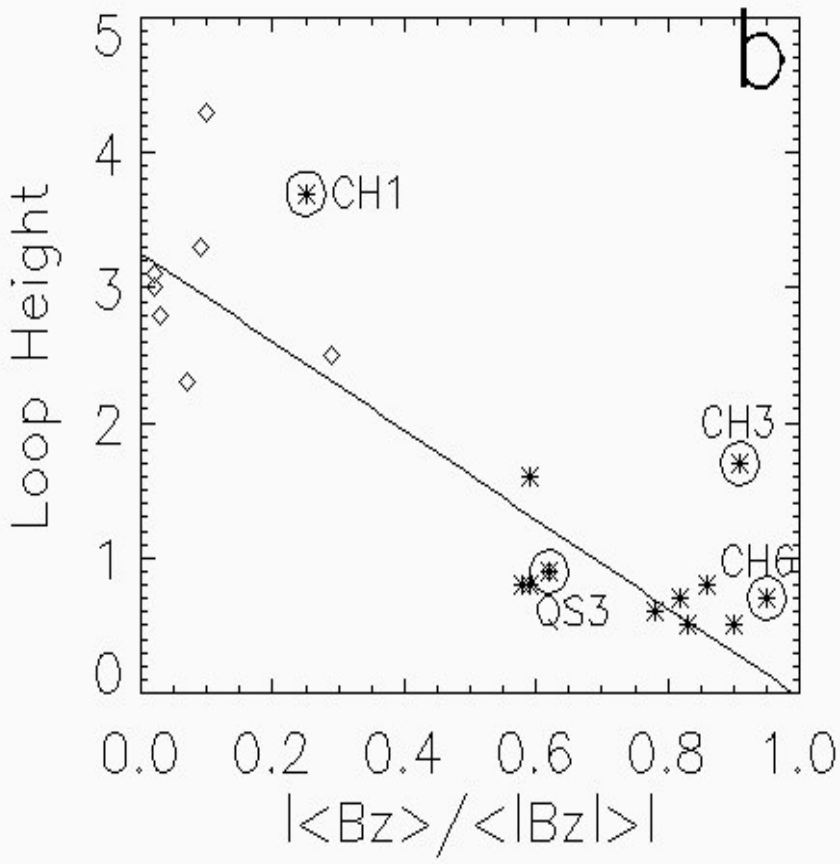
Some statistic properties of coronal holes (CH) compared with the quiet Sun (QS)

We investigated 12 CHs identified in He I
(NSO/Kitt Peak coronal hole maps prepared by
Karen Harvey and Frank Recely)

	CH	QS
Net flux	7.6 G +- 4.8 G	0.4 G +- 0.4 G
Unbalanced flux	77% +- 14%	9% +- 9%
Ave loop length	7.8+- 3.9 Mm	14.1+-4.1 Mm
Ave loop height	0.9+- 0.4 Mm	3.0+-0.7 Mm

Unbalanced magnetic flux vs. loop height and length

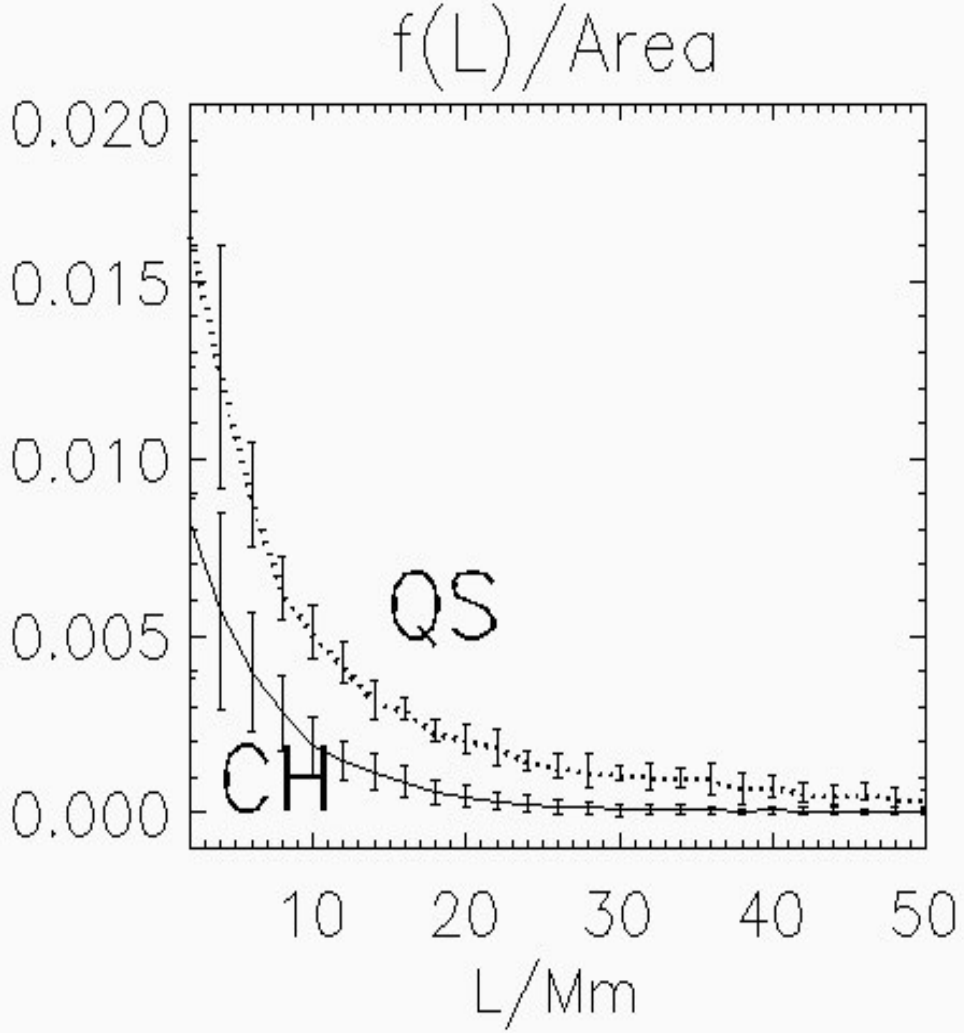


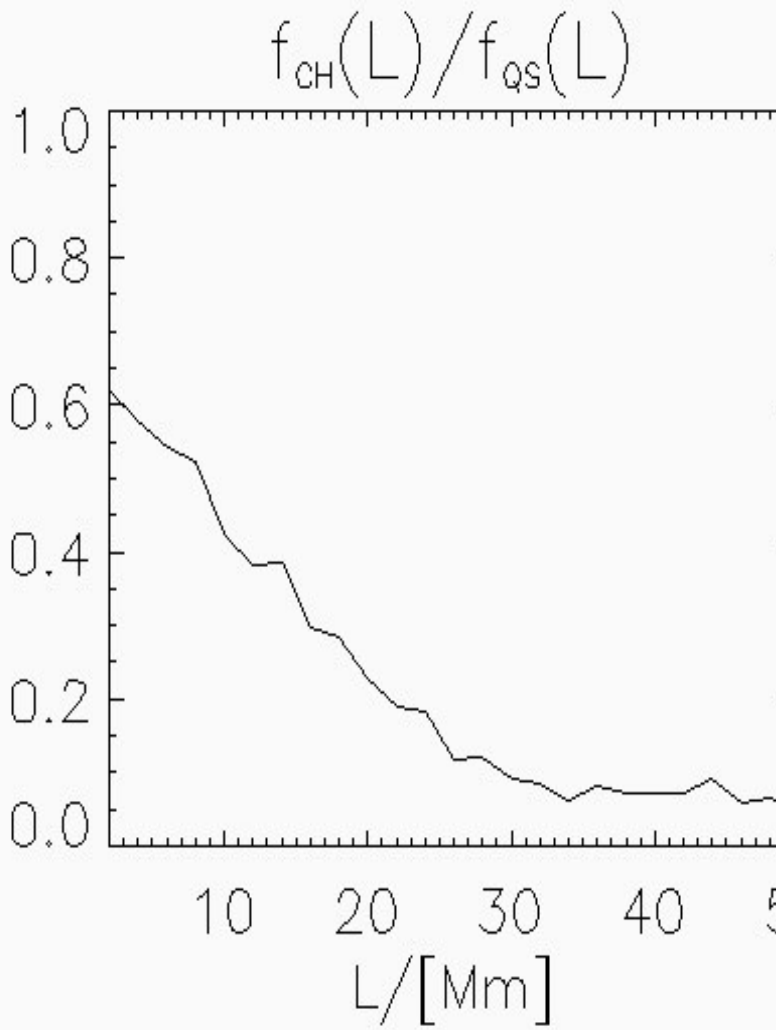


Coronal holes (*) have large unbalanced magnetic flux

=> Loops are shorter and lower than in the nearby quiet Sun.

Distribution of loop length f(L) in Coronal holes and quiet Sun

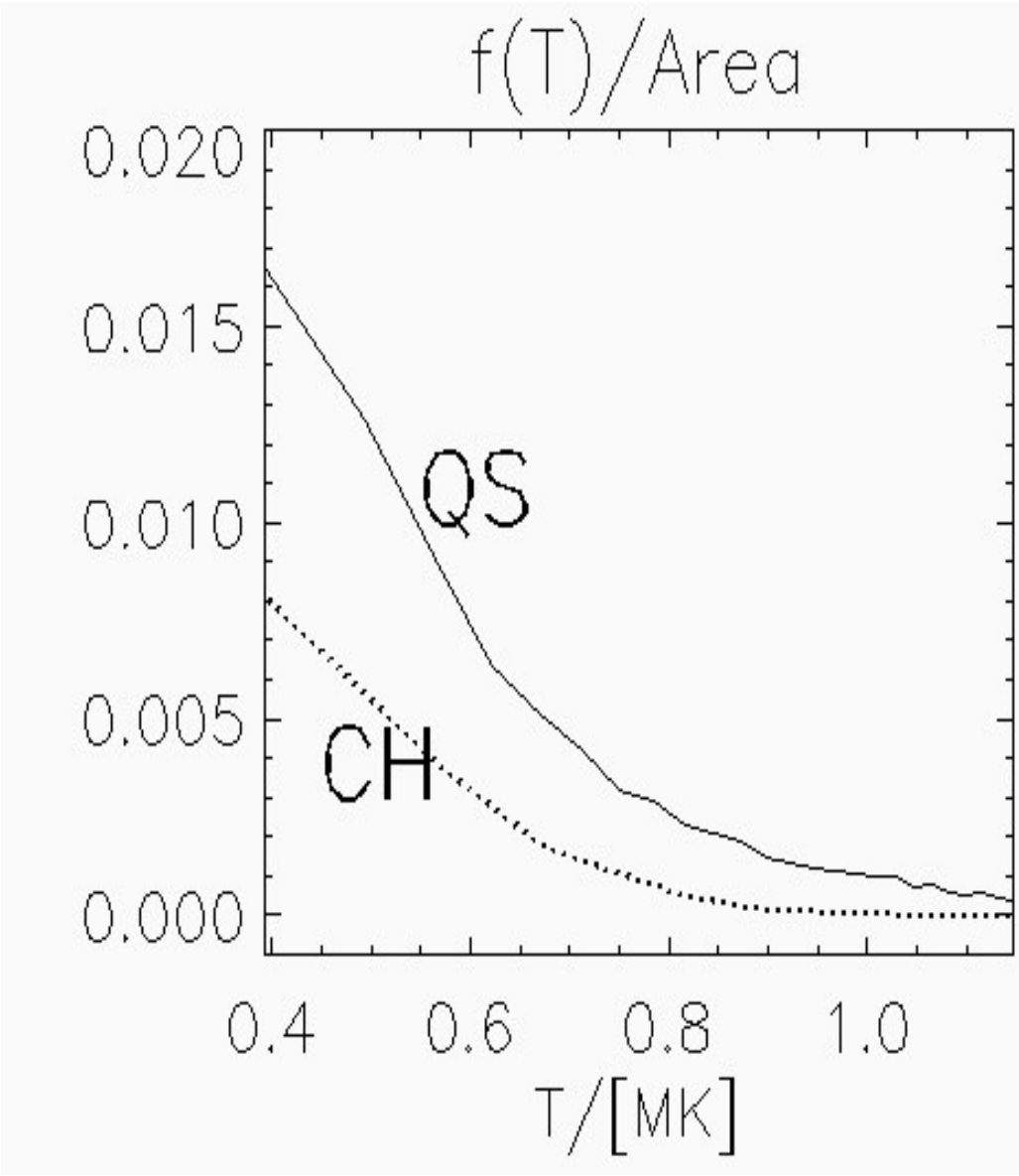


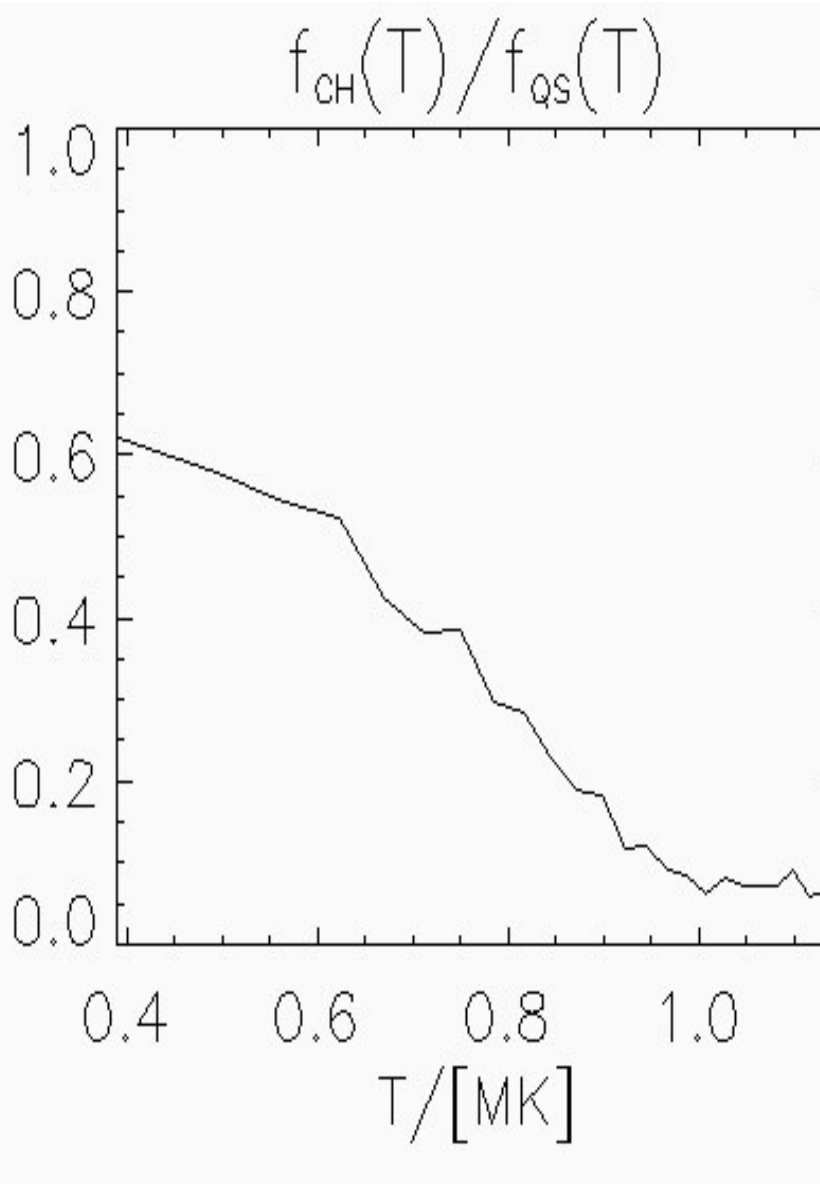


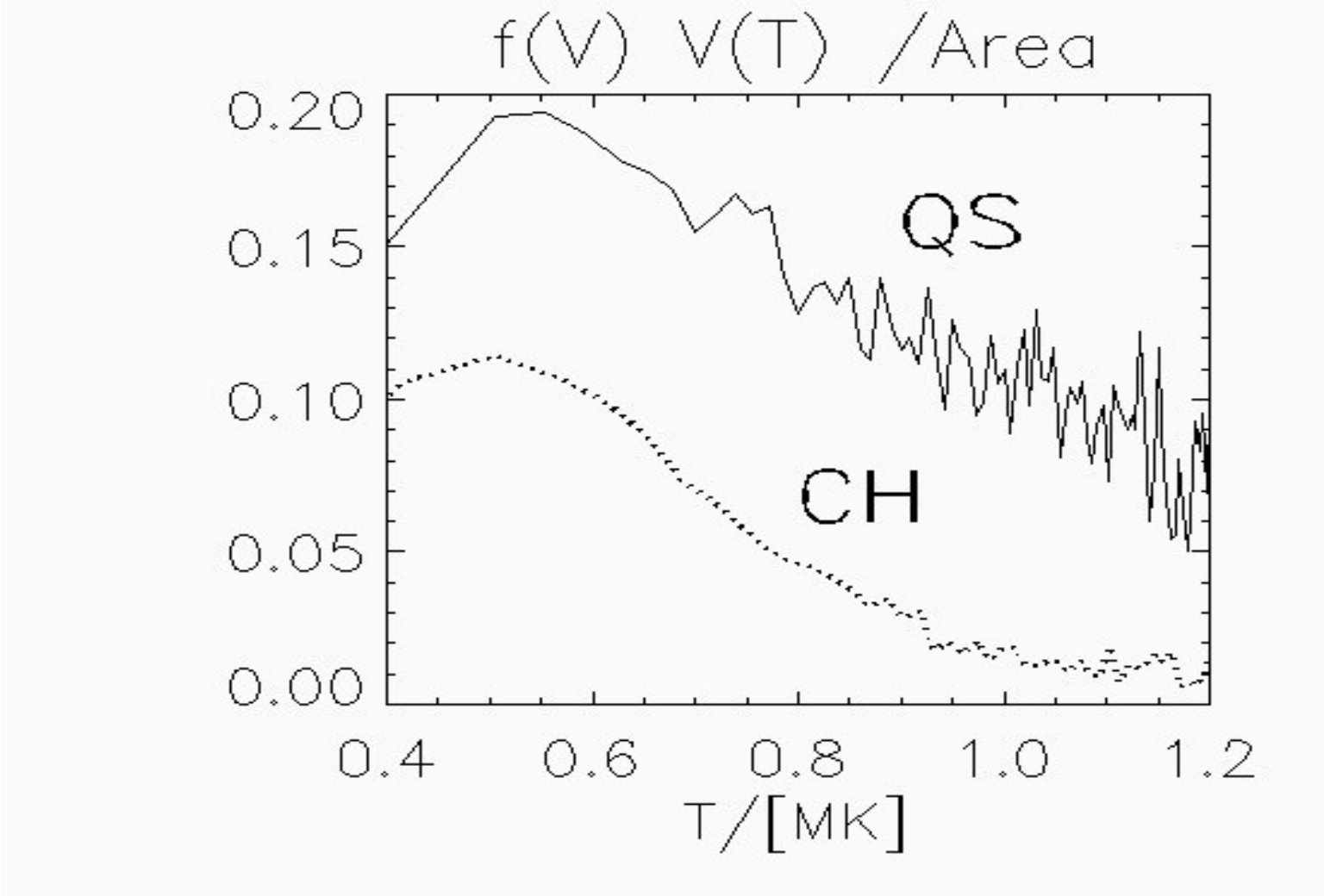
Loop length and temperatures

- Rosner, Tucker and Vaiana (RTV 1978) developed scaling-laws with help of a hydrostatic loop model (no plasma flow, zero gravity, uniform heating and constant cross section)
- $T \sim L^{1/3}$
- We use the scaling law to compute the temperature distribution f(T).

Temperature distribution f(T)







The emitting volume filled by gas at that temperature corresponds to the emitted radiation.

In CH ~70% at low and ~10% at high temperatures compared with the quiet Sun.

Conclusions

- Large net magnetic flux in coronal holes (CH ~80 %, QS ~ 10%)
- Long loops are almost absent in coronal holes
- Number of small loops is only slightly reduced
- Long loops are hot, small loops cold ($T \sim L^{1/3}$)
- Strongly reduced emission in CH for hot coronal lines (~10% of the emission in QS)
- Only slightly reduced emission in cooler transition region radiation (~70% of QS)