Searching for solar nanoflares

Aline R. Brunvoll, PhD student at University of Oslo
email: a.r.brunvoll@astro.uio.no

Rosseland Centre for Solar Physics

UNIVERSITY OF OSLO

Nanoflares are solar flares that are (relatively) small and weak. This makes them hard to observe amongst the otherwise dramatic events on the Sun. Nanoflares are triggered by magnetic reconnection.

Nanoflares occur much more often than larger flares. The frequent energy release from nanoflares contributes to the extreme heating of the Solar atmosphere (see: the coronal heating problem).

We want to know: **How much energy is released from nanoflares?**

Then we also need to know:
- How many nanoflares are there?
- How much energy do they typically release?

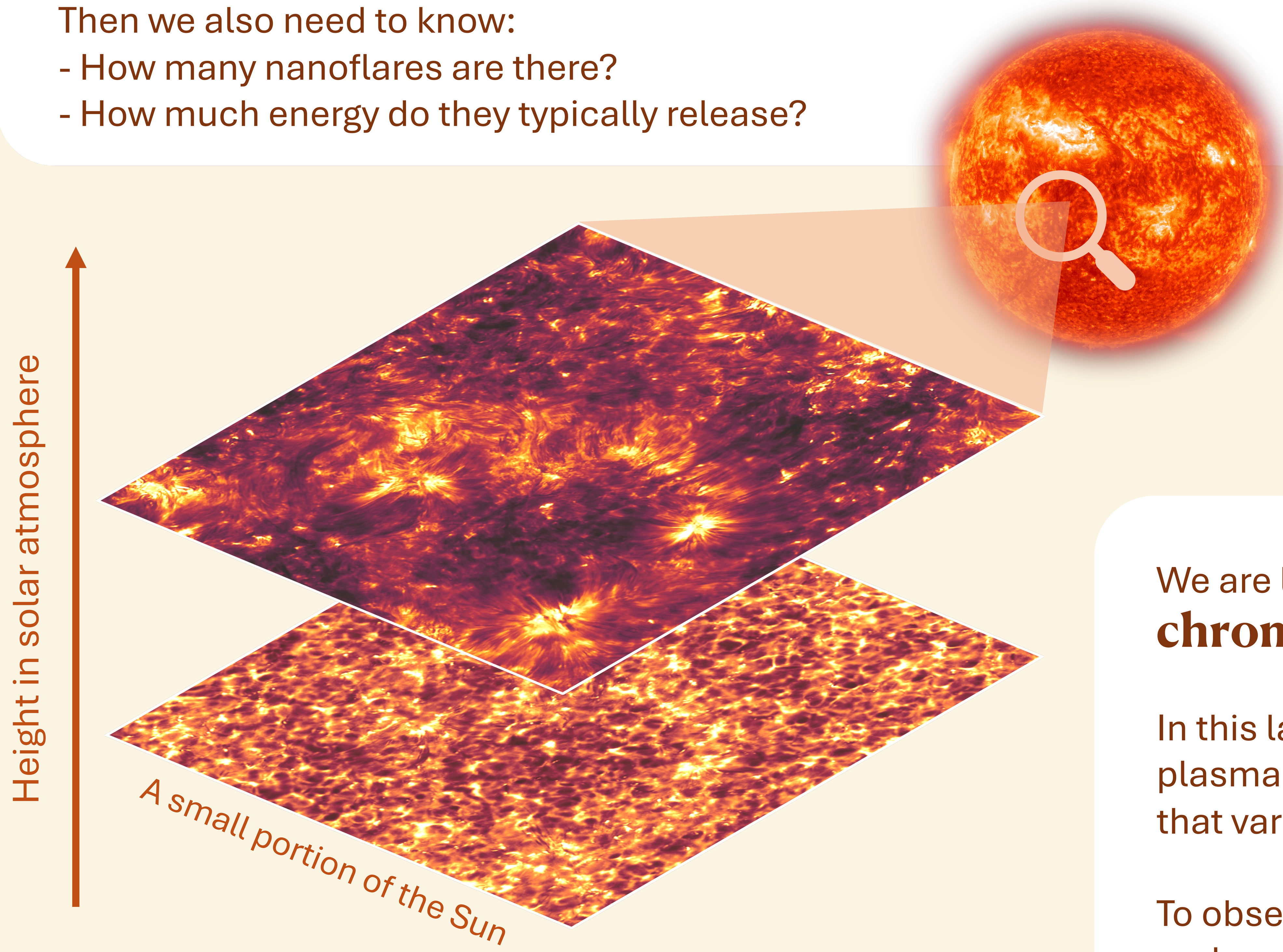
Magnetic reconnection:

When two opposite magnetic field lines get too close, they can ”snap” and reconnect to each other, releasing built-up energy.

The Sun’s magnetic field forms large half-loops in its atmosphere. They move around in the chaotic environment and reconnect on large and small scales.

The coronal heating problem:

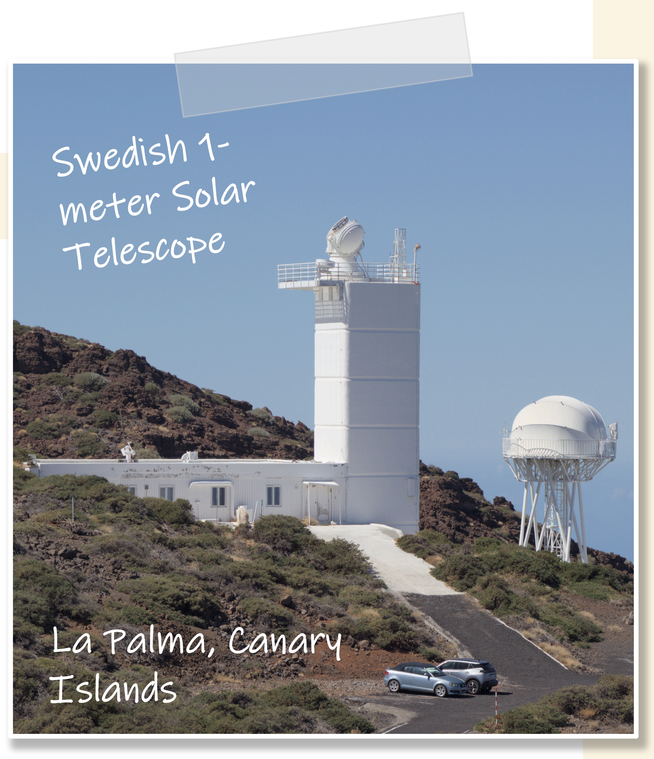
The surface of the Sun (~ 6 000 K) is much colder than the outer atmosphere of the Sun (~ 5 000 000 K)!
What mechanism causes the heating of the outer layers of the solar atmosphere?



We are looking at the layer of the solar atmosphere called the **chromosphere.**

In this layer the magnetic and fluid forces push and pull the plasma in a very chaotic way. The result is a dynamic layer that varies dramatically in space and time.

To observe it well, we need excellent resolution in both time and space. This is difficult to achieve!

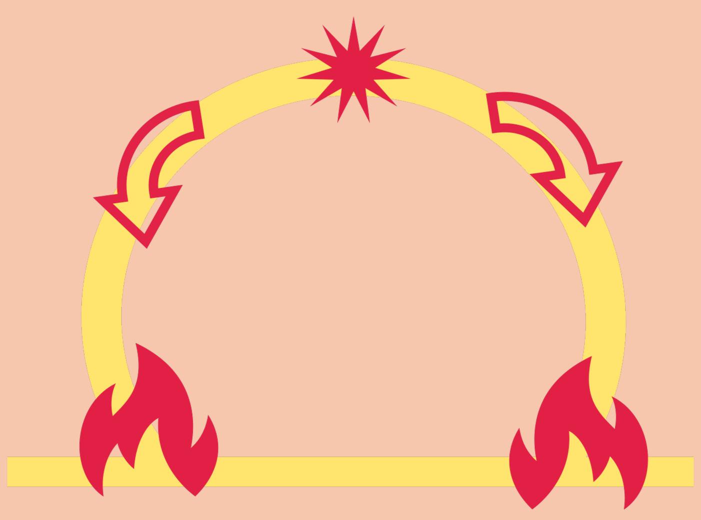


How do we look for nanoflares when we don’t really know what they look like?

Simulations let us predict what nanoflares will look like in observations.

The simulation is 1D and aligned along a magnetic loop. A reconnection event at the looptop sends a beam of non-thermal electrons downwards.
When it reaches the chromosphere, the plasma gets heated and emits light at certain spectral lines.

This shows us which spectral signatures we are looking for in the real observations.



To detect nanoflares in observations we will use **machine learning detection algorithms.**

Nanoflares are small and weak, ”hiding” among the backdrop of the chromosphere, making it hard to spot them manually.
We will use feature detection to find the nanoflares in observations, and data clustering to characterize the nanoflares.

Other reasons to avoid manual detection are:
- The datasets are large with thousands of pixels per timestep and with four dimensions (x, y, time, wavelength)
- There is already a big collection of observational data available for analysis

I welcome discussions and input! :)