Modelling Electron Acceleration in Solar Flares

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Eduard Kontar, Nicolas Bian and others

What is a Flare?

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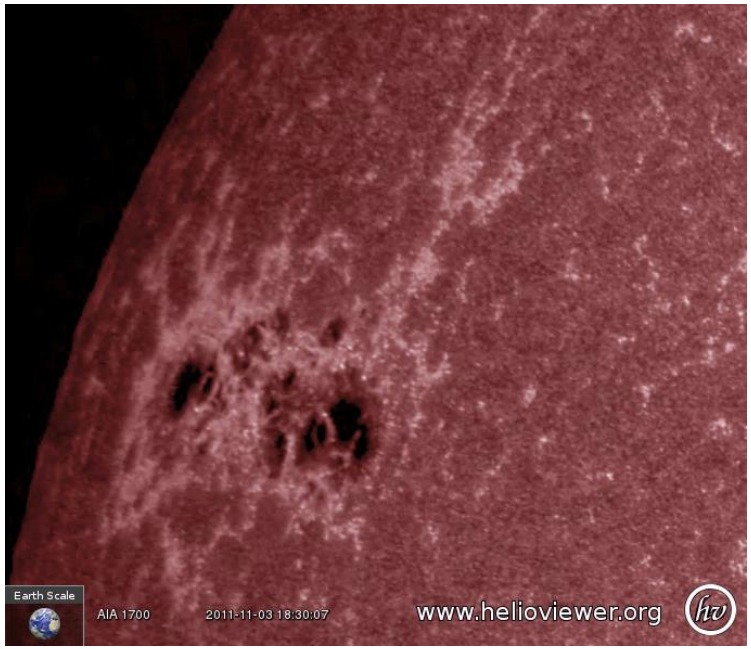
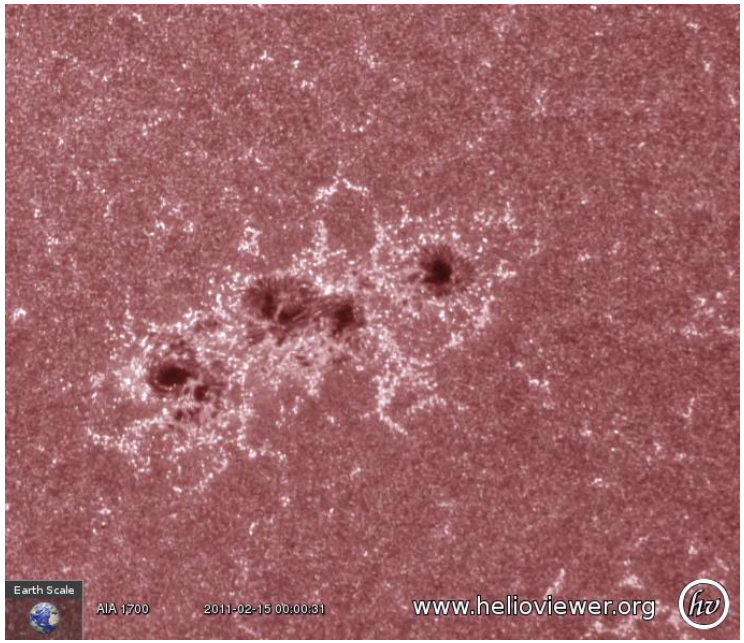
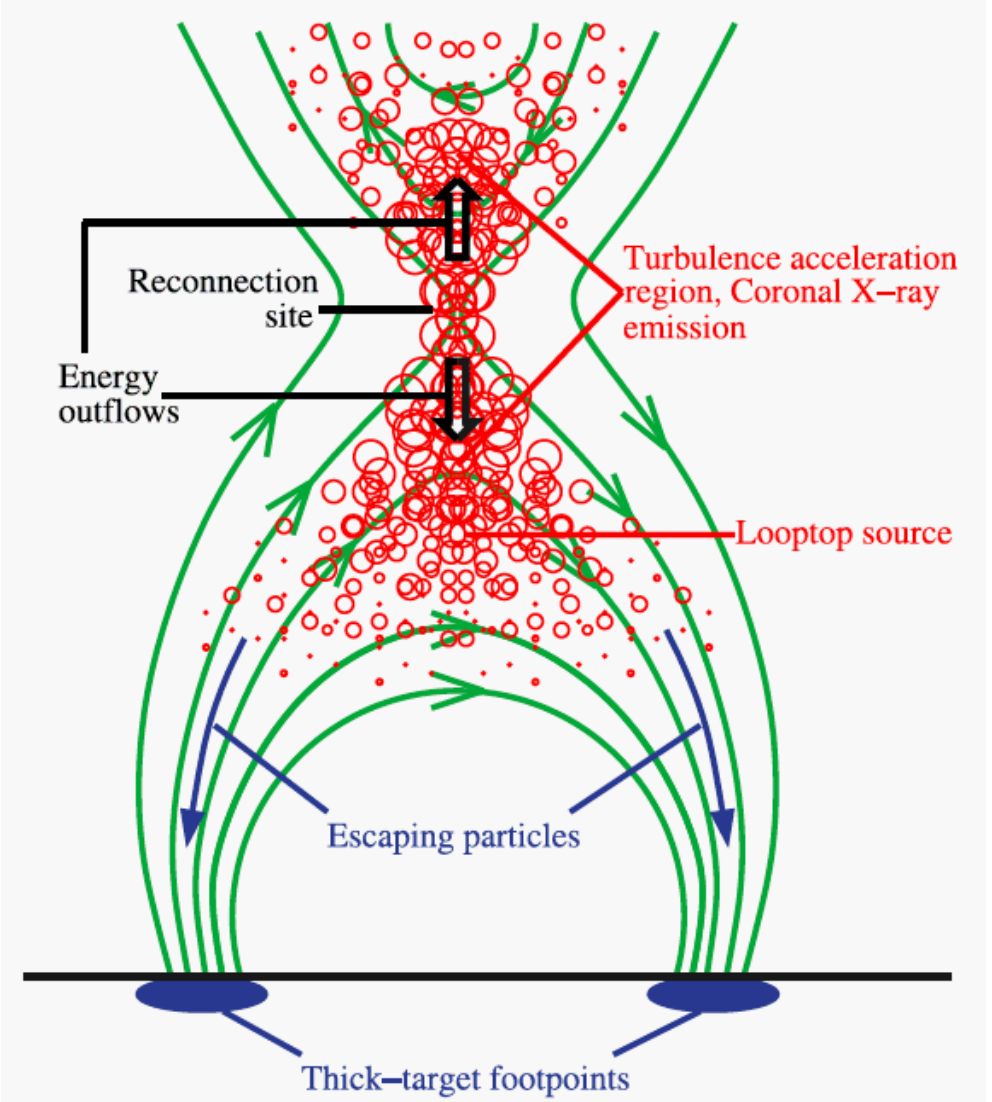




Thanks to Graham Kerr for the videos.

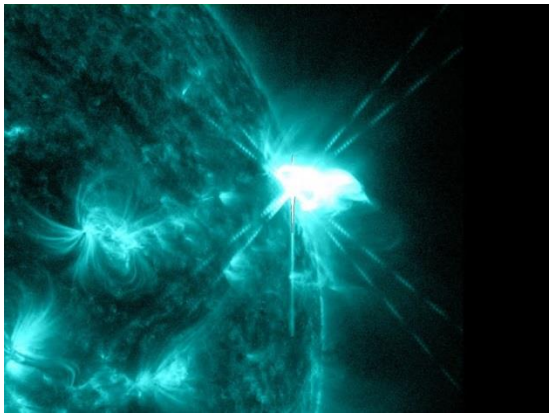
What is a Flare?

- Basically a restructuring of the Sun's magnetic field.
- Releasing an amount of energy equivalent to billions of nuclear bombs
- A significant portion of this energy goes into accelerating particles
- We see signatures of these particles in observations and attempt to corroborate with numerical simulations

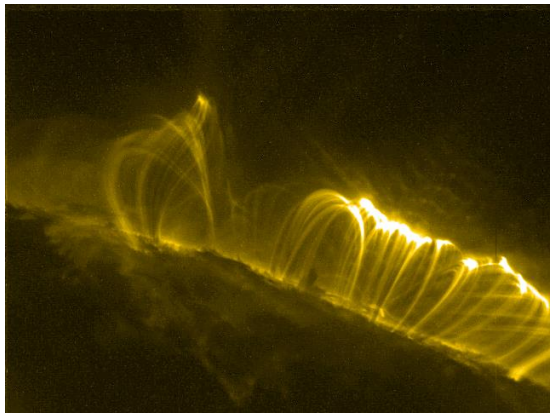


Liu et. al. 2008

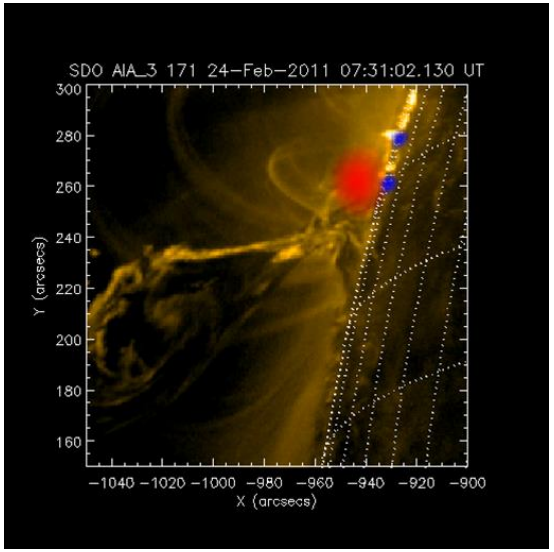
What do we see?



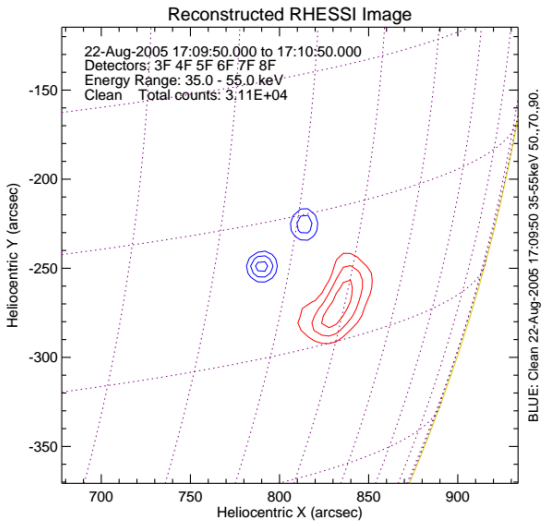
SDO: NASA



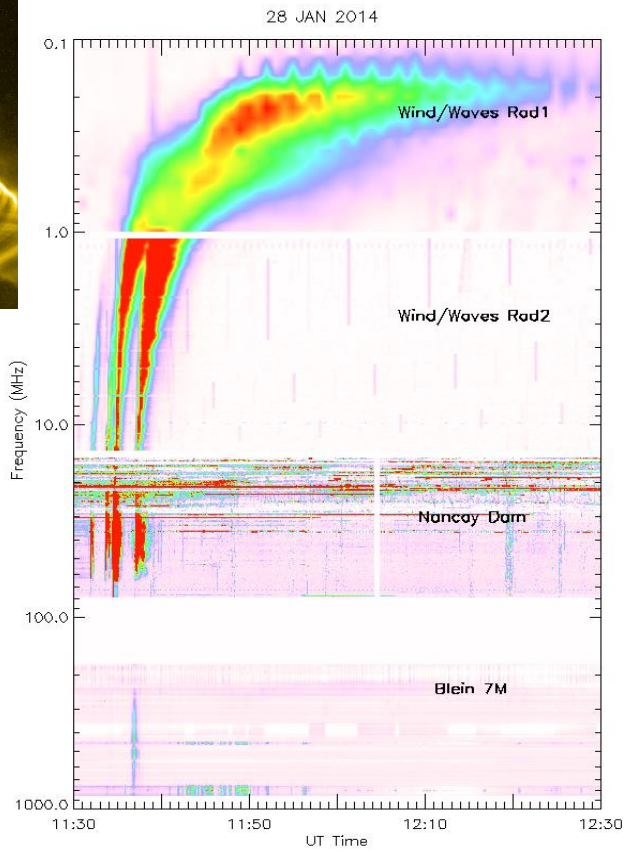
TRACE: NASA



SDO with RHESSI: NASA

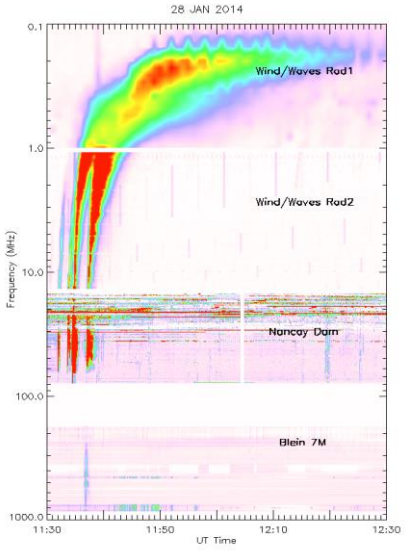


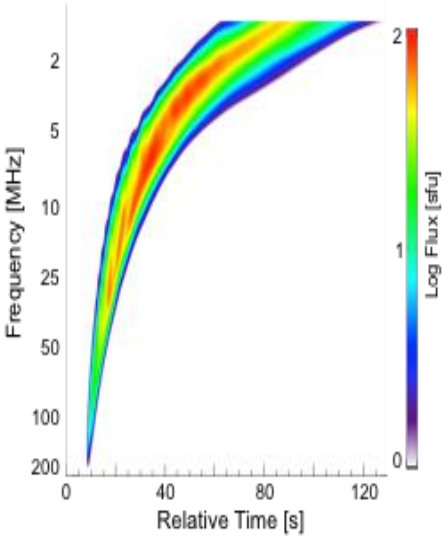
RHESSI: NASA



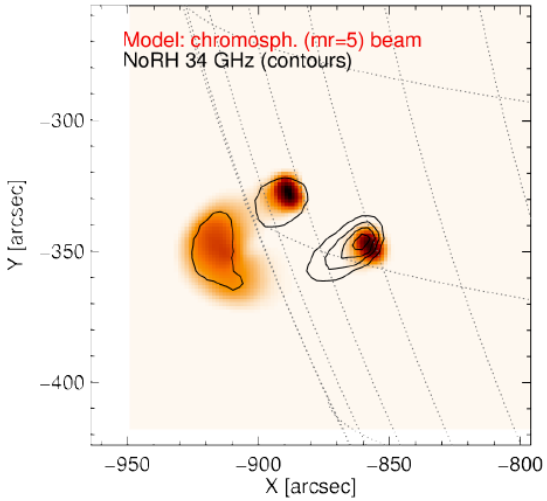
Modelling

- Take observations – postulate physics involved.
- Run model described by such physics.
- Tweak until you get good agreement.
- Observations affected by instrument resolution, may be other effects going on we can't see!
- Modelling affected by computation power etc…

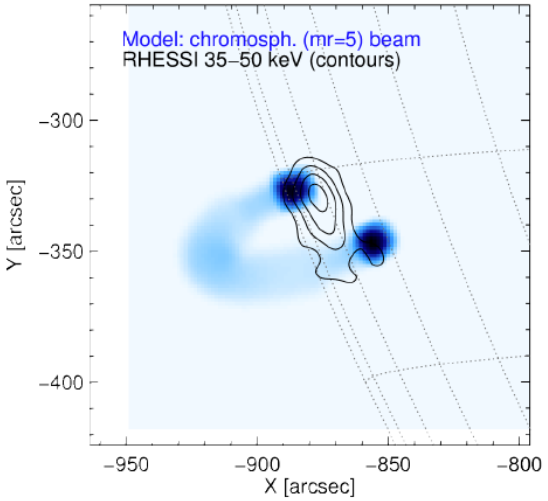




Reid et. al.



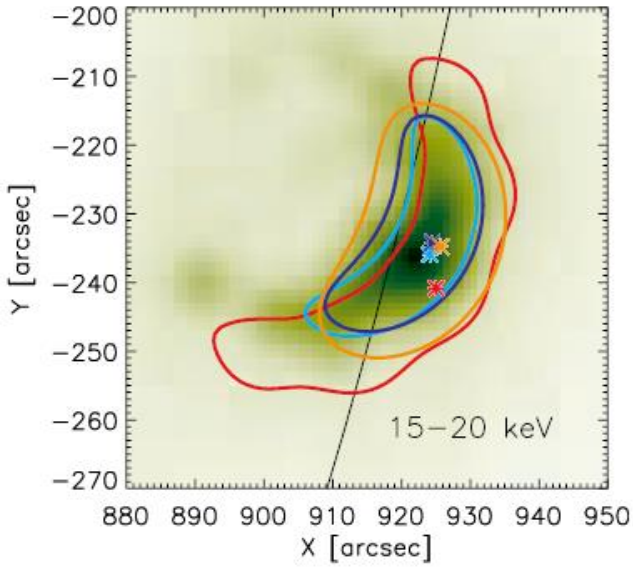
SOL2003-10-24



Simoes et. al 2013 (CESRA)

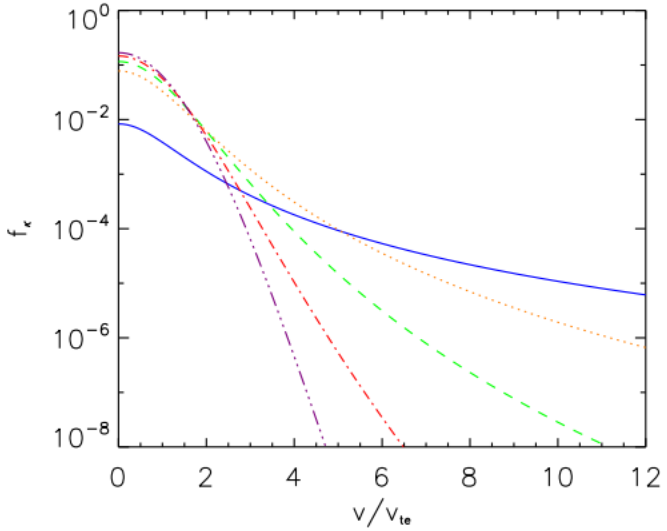
Example

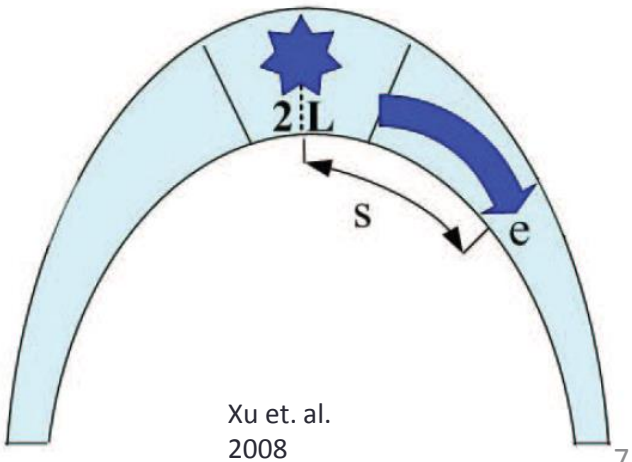
- We see a flare where most emission is from the looptop.
- Know that collisions must play a large part in this emission.
- Create a model describing electrons where collisions and acceleration balance.
- Solve analytically and numerically to find solution.
- Find that the electrons are defined by a kappa distribution.
- Look for flares with this particular spectrum!



Jeffrey and Kontar 2013

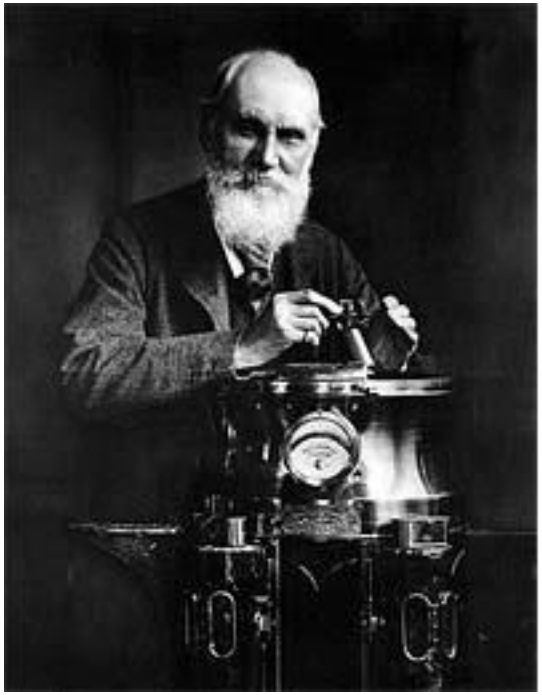
Bian et. al. 2008

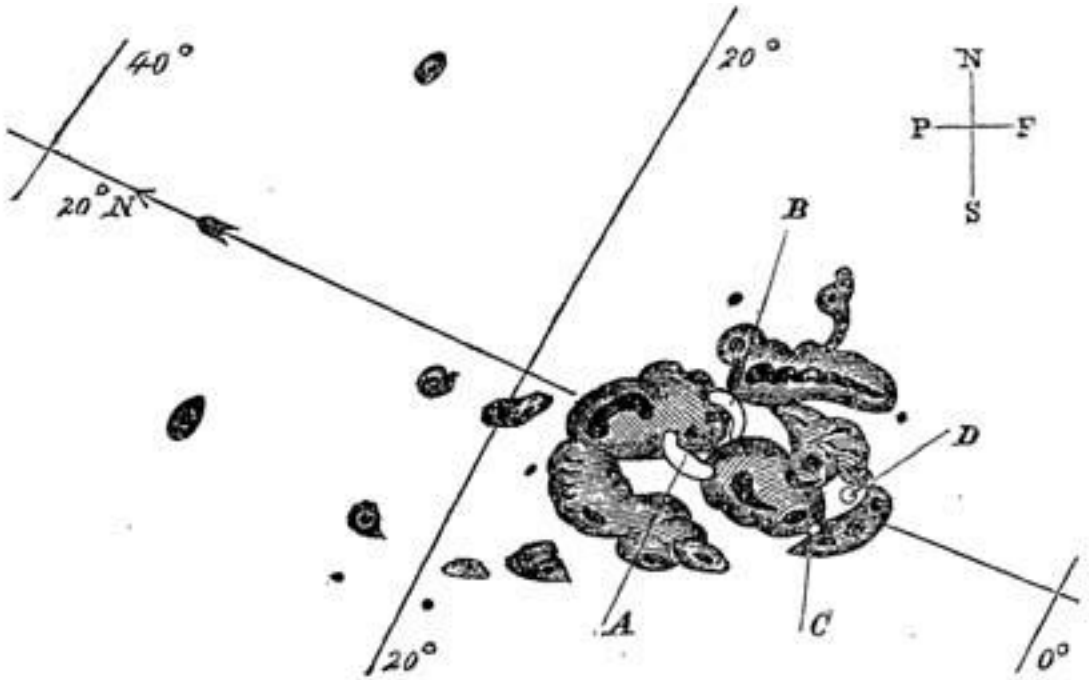




Xu et. al. 2008

Why do we care?





- 4th most important risk to U.K. (U.K. risk register)
- A powerful solar flare, properly aligned, could pose serious threats to our telecommunication and power networks.
- Understanding the processes intrinsic to flares enables better prediction.

Summary

- ‘Marriage’ of observations and models needed to understand solar flares in greater and greater detail.
- With greater computing power our models get better.
- New missions will provide more and better data.
- Integral to keep way of life safe from a catastrophic solar event.