Implications for coronal heating and magnetic fields from coronal rain observations and modelling

ISSI Team in Space Sciences

The team

18 members - 10 countries

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Goals

- Partially ionised cool and dense plasma falling from coronal heights towards the solar surface

Coronal rain & Prominences

➡ Morphology, dynamics, and energetics through observations, modelling and theory

- Implications in major research fields:
  - Coronal heating
  - Thermal instability in low-β plasmas
  - Magnetic field topology (small and large scale tracing)
  - MHD waves and coronal seismology
  - Partial ionisation effects
  - Chromosphere-corona mass cycle
  - Mass accretion unto stars
- Major deliverable: Papers (collaboration!) & SSR review.

Important questions

- What are the characteristics of thermal instability in the solar corona (time and spatial scales)? How complete is the instability in general? How common is it in the corona?
- How are the characteristic spatial scales of catastrophic cooling plasma generated? How do plasmas and fields interact in low-β?
- What is the role of coronal rain and prominences in the chromosphere - corona mass cycle?
- Which physical mechanisms are behind the less than free fall speeds of coronal rain and prominence material accreting towards the surface?
- How multi-thermal are partially ionised plasmas and what is their degree of inhomogeneity?
- Is EUV variability in loops strongly linked to thermal non-equilibrium states (and to coronal rain)?
- Which physical processes are responsible for the morphology (clumpy state, strand-like structure)? Are such scales fundamental in the corona? Does thermal instability play a major role in the shaping and heating of the corona?
- What is the ionisation state within coronal rain? Which partial ionisation effects are important in coronal rain?
- Is partially ionised material such as coronal rain unique tracers for the fine scale and global magnetic field structure of loops? Can they be tracers for Alfvénic MHD waves (and wave energy indicators)? Can they be tracers of turbulence in the corona?

To do

- Partial ionisation effects: higher perpendicular thermal conduction -> larger spatial scales in thermal mode (->Roberto, Teimuraz)
- PCTR & chromosphere-TR transition: check with simulations (->Xia)
- Statistical analysis of rain/prominences for differences & similarities
- Terminal speeds relation with location where rain falls & sunspot characteristics (size…)
- Do some more spectropolarimetric measurements of coronal rain
- How fast can coronal rain be?
- Check correlation between bursty features and velocity
- Check 2-step scenario during catastrophic cooling & timescales of catastrophic cooling
- Is the generation mechanism wave-related (shocks?) or flow-related (inverse Evershed-effect, thermal instability, siphon flows)?
- Could coronal rain produce strong UV/EUV & X-ray in YSO? (could those features be interpreted as coronal rain instead of accretion disks?)
- Does a blob behave more like a wave or like a flow? Is there advection of mass? Check with other more advanced numerical models
- Chromosphere to TR boundary and TR to corona boundary are different, and respond to different physical mechanisms

Field tracing

Alfvénic waves

Wave energy

seismology

field topology

turbulence

Scales

transverse **longitudinal**

0.2” → 60”

clump width	shower width	clump length	shower length
Transversal Field length?		Longitudinal Field length?	
magnetic strands?		KHI?	
tangential discontinuities?		Pinching?	
PCTR		Flare ribbons?	

Dynamics

transverse	**longitudinal**
transverse oscillations	longitudinal oscillations
drifts?	Low acceleration
flocculent flows	
	solitons
transverse MHD waves	pressure restructuring?
	magnetic pinching (sausage waves)?
	slow modes

Mass cycle

chromosphere-corona mass cycle

Occurrence frequency

Loop EUV variability

multi-thermality

redshifts above sunspots

stellar connection

impacts on lower atmosphere

Plasma state

Optical thickness

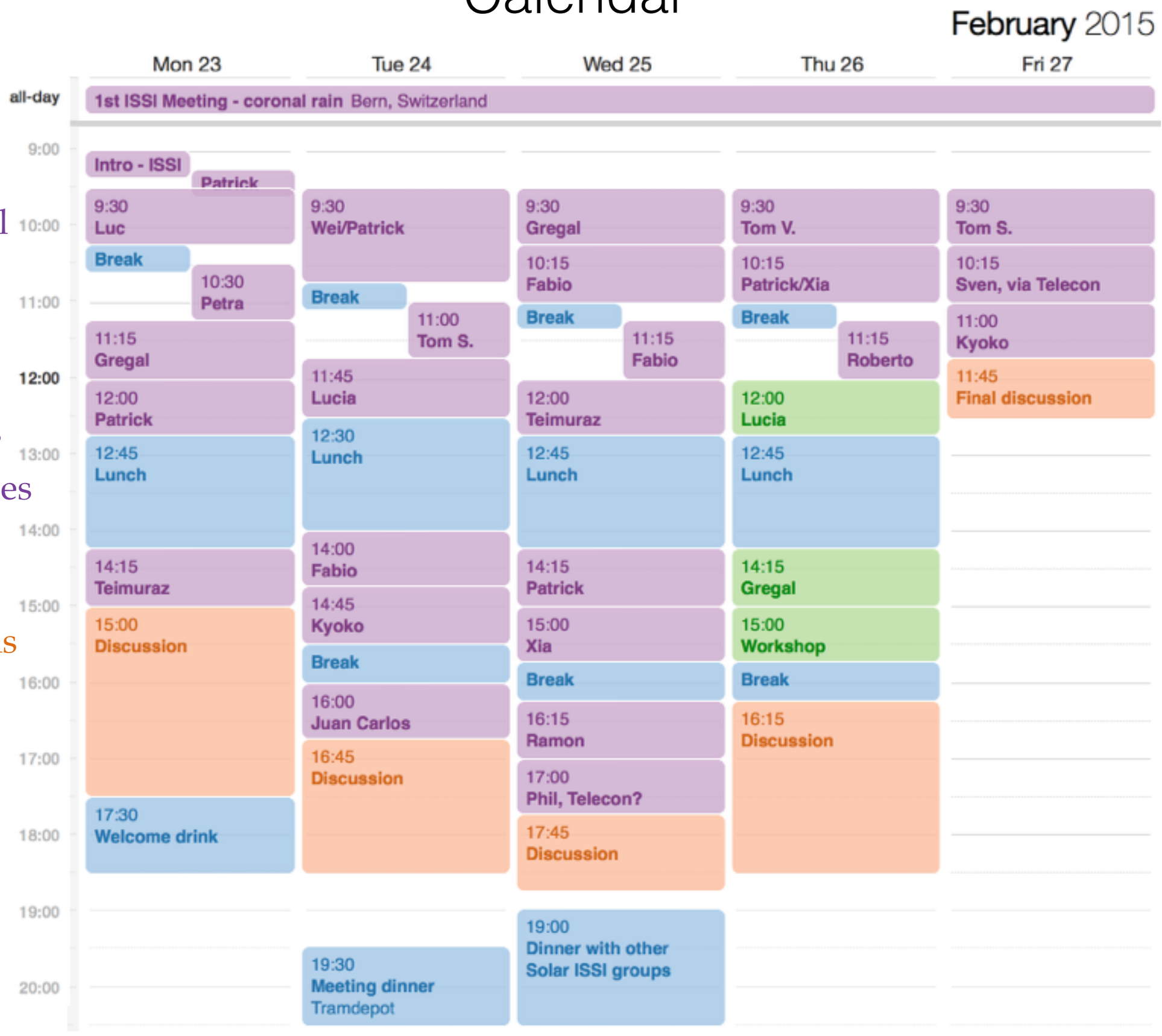
partial ionisation effects

2-step cooling

Calendar

- Observations
  - Standard model
  - Post-flare loops
  - Associated phenomena
- Numerical models
- Theory - instabilities & waves
- Future prospects
- Discussion sessions
- Workshop

Talks: 45 min
(30+15)



Discussion sessions & workshop

- Discussion sessions:
  - possible ways of collaboration to achieve goals of meeting
  - working groups: data analysis, modelling & theory planning
  - SSR review paper planning: sections, aims, milestones, time frame

- Workshop: optional
  - IRIS data analysis (coronal rain data set)
  - CRISPEX tutorial