



# GRASPING THE INVISIBLE

Fine Structures in the Solar Corona

Grasping the invisible is a project in the field of **Solar physics**

what: develop a **new research method** that might **reveal previously hidden science**

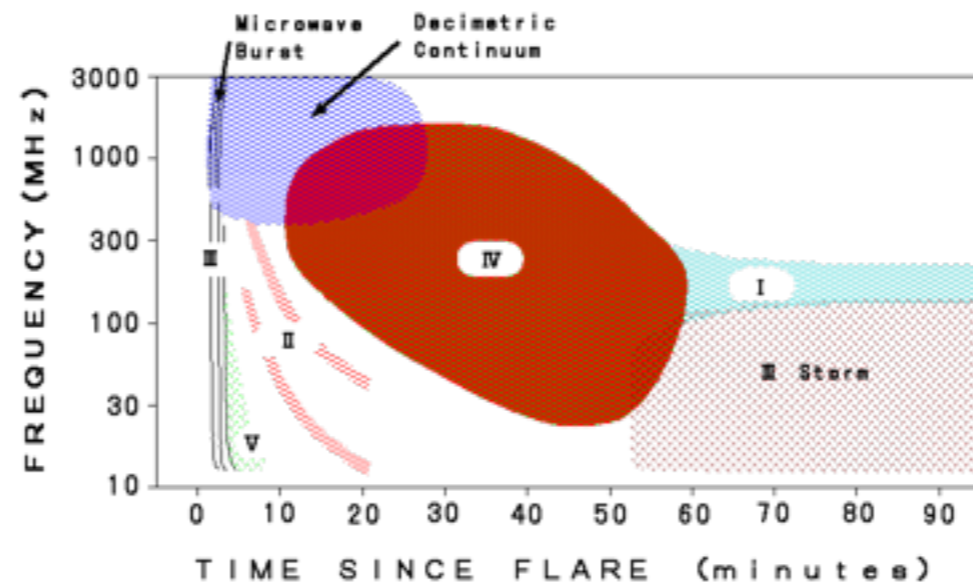
By presenting **solar data in an other format**, we want to get a **larger group of people involved that contribute to research**.

The sun is our favourite star that shines during the day. It is the main driver of our climate but also the driver of that other weather, space weather.  
The **solar atmosphere is one of the keys in space weather**.



Image: Siberia 20080801  
J.M.P., W. G. Wagner and H. Druckmüllerová

Space weather ingredients like flares, coronal holes, coronal mass ejections leave a **footprint in the coronal plasma**. For example, CME's are clearly visible in coronagraphs, you see a large bulb passing.  
**But not all coronal structures can be seen just like that.**



# RADIO WAVE BURSTS

5 types

We can measure the **solar e.m. radio output and put it into a spectrogram.**

At low frequencies, **5 types** of radio wave bursts are seen, **each with a unique signature in frequency and time.**

These bursts are triggered by a solar event

A type II burst is caused by a shock that triggers the local plasma to emit radio waves. While **most of the interplanetary shocks are CME-driven, coronal shock waves can be attributed to solar flares**, CMEs, or some combination of these two phenomena. Since the acceleration phase of the CME and the flare impulsive phase are usually closely synchronized, it is **hard to distinguish between the flare energy-release effects and the CME expansion.** Due to this problem the origin of the coronal shocks, i.e. metric type II bursts, still remains unresolved.

Type II

type II burst, slowly drifting, often with fundamental/2nd harmonic structure, due to plasma emission

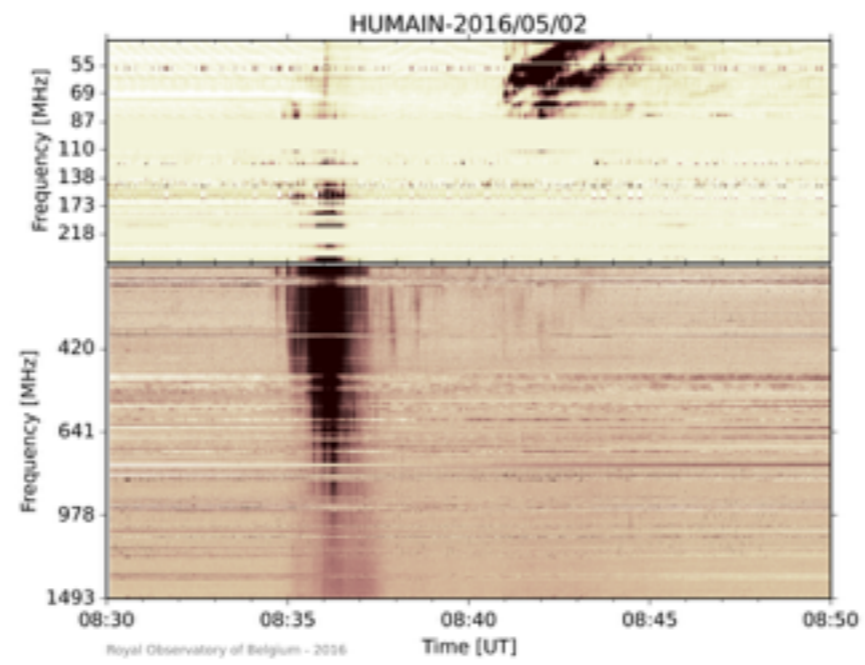
cause is a shock wave, propagating at 500–2000 km/s outward into the corona into interplanetary space (also seen down to kilometric wavelengths).

Type III

○ type III burst, rapidly drifting, often with fundamental/2nd harmonic structure, due to plasma emission. The fundamental is highly o-mode polarized, and the 2nd harmonic is weakly (15%) x-mode polarized.

▪ cause is a stream, or **beam, of electrons moving at speed  $\sim c/3$ , propagating from low corona into interplanetary space** (also seen down to kilometric wavelengths).

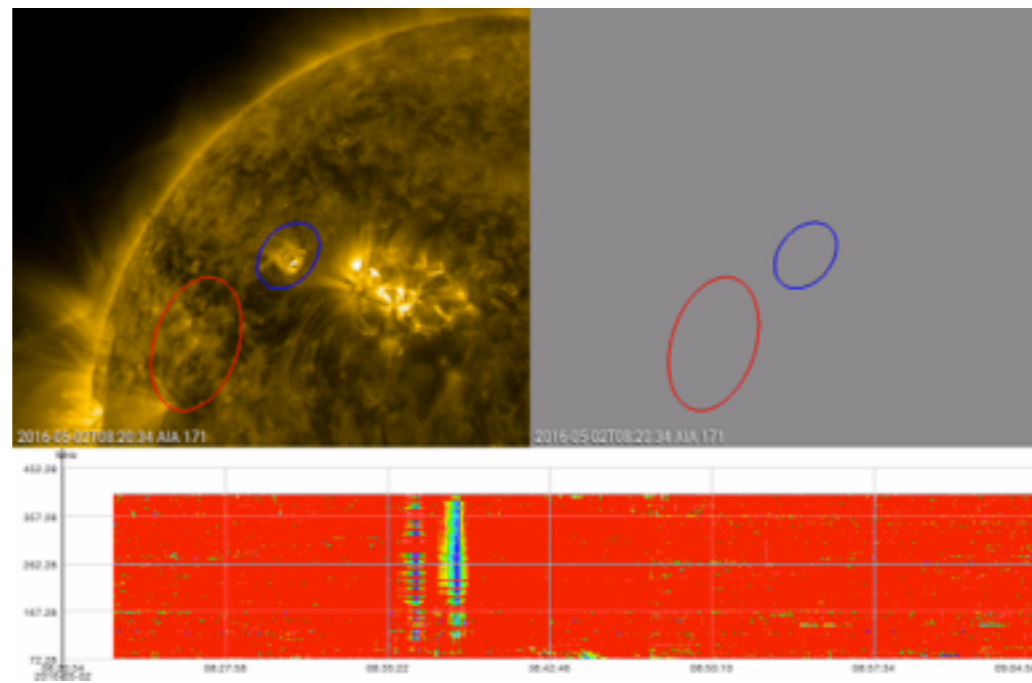
○ type III storm -- a long lasting (up to a day or more) series of type III bursts, RS (reverse slope) bursts, reverse-drift pairs, and continuum.



# TYPE II SOLAR RADIO BURST

Humain data

a case study



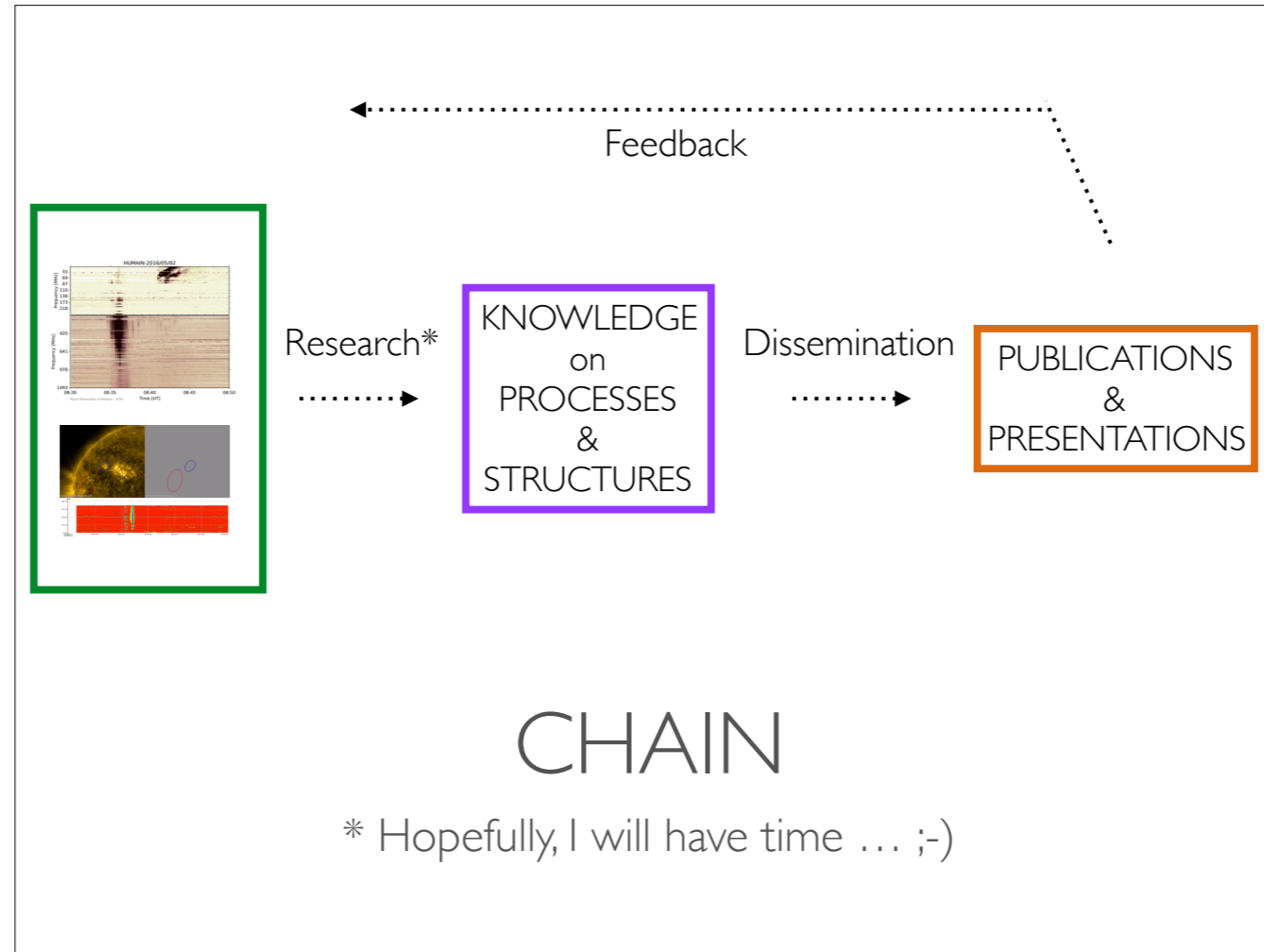
## OTHER DATA

Flare - dimming indicated the presence of a CME

- 1) ejecta from blue circle
- 2) flare in blue circle
- 3) dimming in red circle

The radio burst is synchronized with 2)

rather fast shock: is more probably associated with the impulsive flare and not with the slow CME.



Data are investigated and interpreted with conventional standards and prescription: time series, parameters and measurements are put in relationship in graphs, scientifically interesting events are described by models, etc.

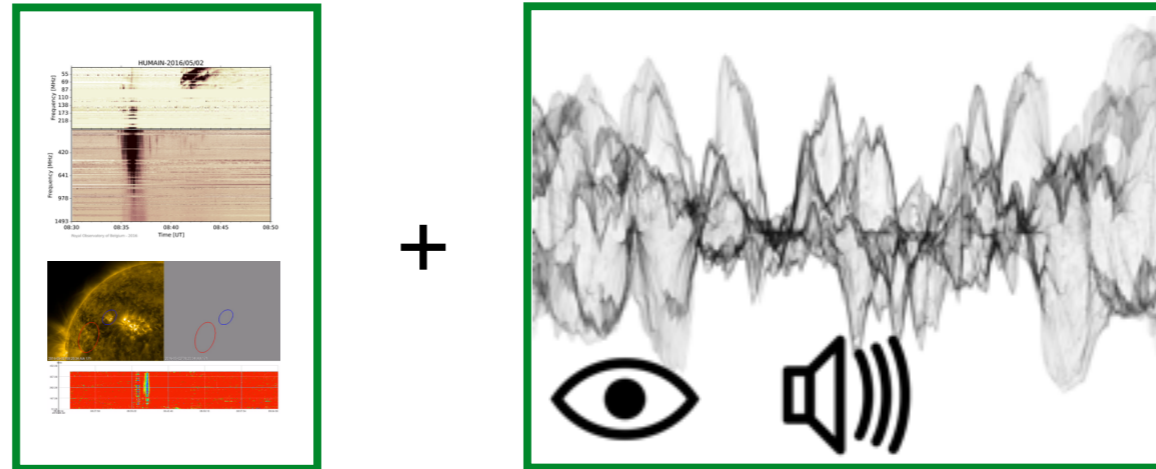
The scientific findings are

- published in research journals impacting a specific science community.
- presented for a scientific public at conferences, workshops, ...

allowing those researchers to perform an in-depth review and giving feedback.

The **intended audience is a small community** :

As a consequence, the **impact is often small** and limited leading to a probably small amount of feedback.



## NEW REPRESENTATION OF THE DATA

Allow other ways to analyse data  
 Interpretable by people with no formal scientific education

we want to **enlarge the ways to interpret data** and offer a **visual and sonic/auditive experience**

two formats that deal with 2 senses: sight and hearing

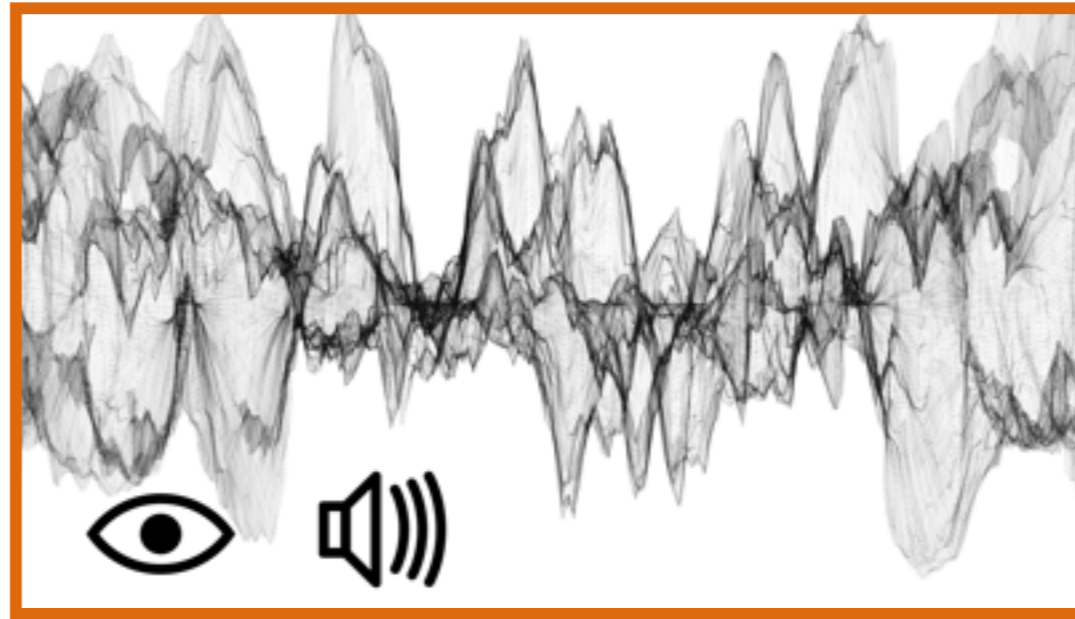
This pioneering project explores the junction between science and 'art' and will develop new research methods that allows to reveal previously hidden science.

**We will objectify the data in another way such that other people then scientists can interpret the data.**

The data is objectified by means of sonification and aesthetical visualisation.

—> retrieve additional information that was previously hidden





## DEMOS - OBJECTS - COURSES

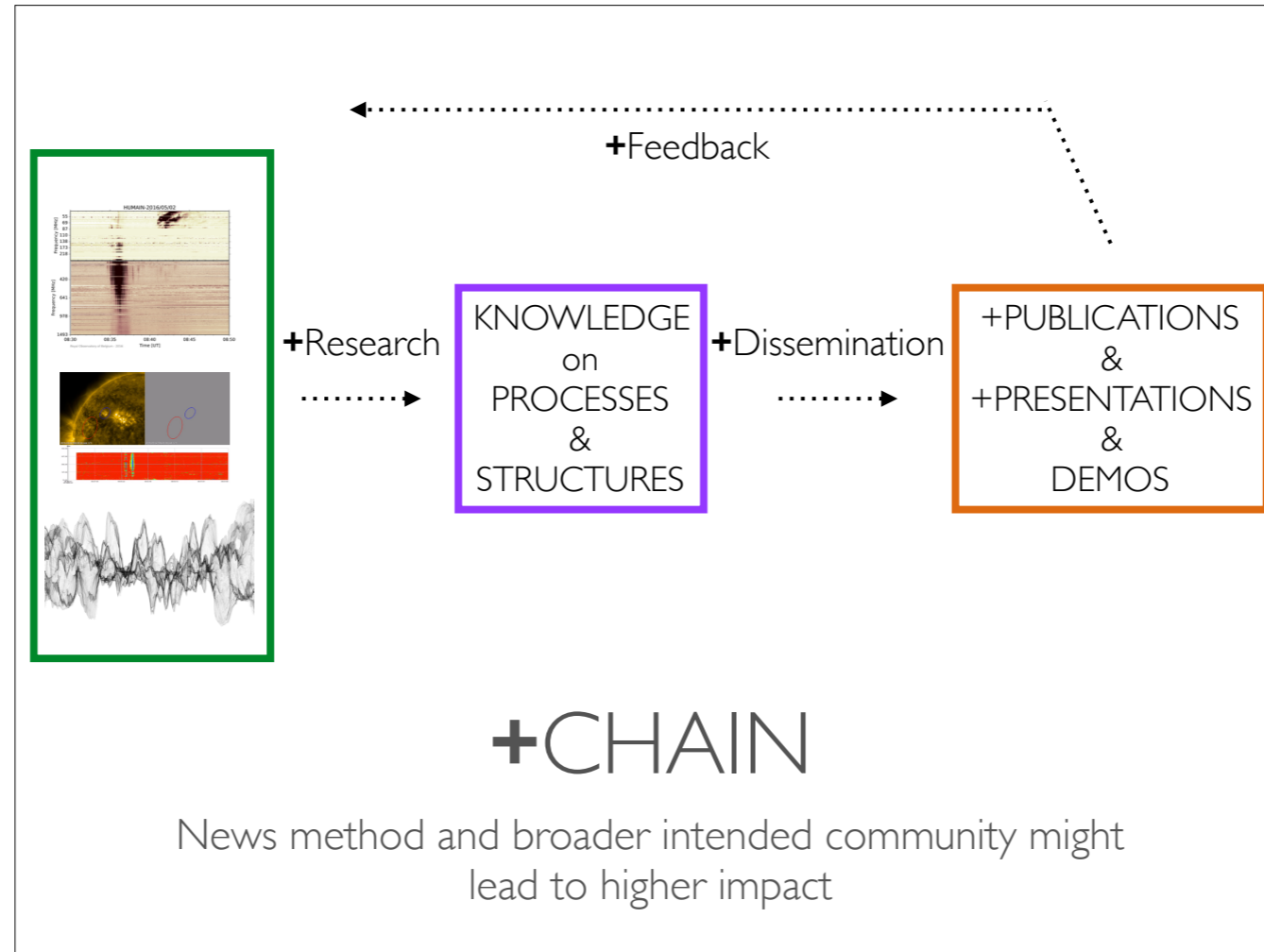
With a little help of our partners

Pro-active approach: we bring the data and conclusions to people

Services for a broader community with (art) demonstrations as the tool to disseminate scientific results.

- ✓ Solar radio astrophysics groups
- ✓ ROB
- ✓ Planetarium
- ✓ Coordination Cell of the STCE
- ✓ Royal Academy of Fine Arts Antwerp
- ✓ International network Pepa built





Allowing a larger group to participate in science by offering the data in another form.

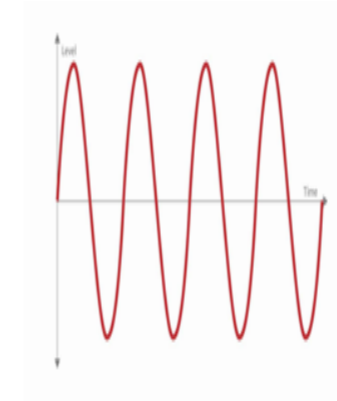
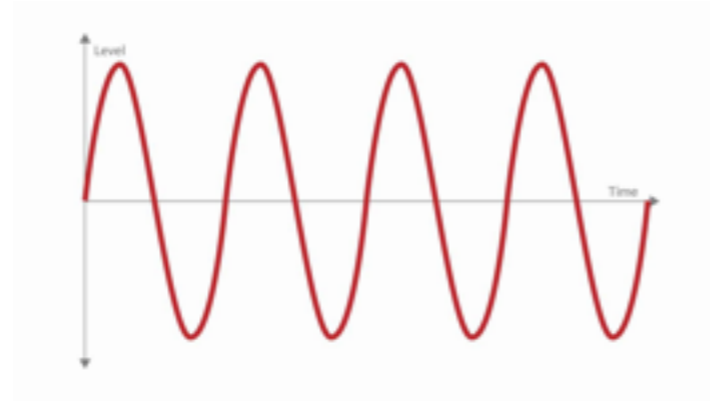
+ research: **scientist AND people without a formal science education but willing to contribute to science**

Because the new method allows other groups to contribute

+dissemination: **extra channels to disseminate the results** – exhibitions, other sort of journals and magazines

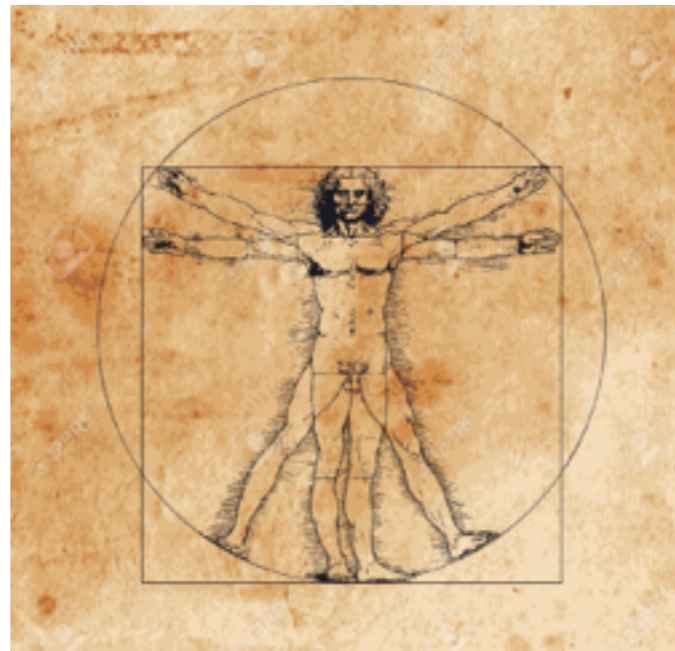
+ Feedback: because **the number of people you reach is larger**, because **the sort of people you reach is different**, you will possibly enlarge the impact:

- more feedback on the specific topic
- a growing interest in science



## LOW TO HIGH TONES

Also people with no formal scientific education can interpret data



# ACCESSIBLE SCIENCE

Strength of a group

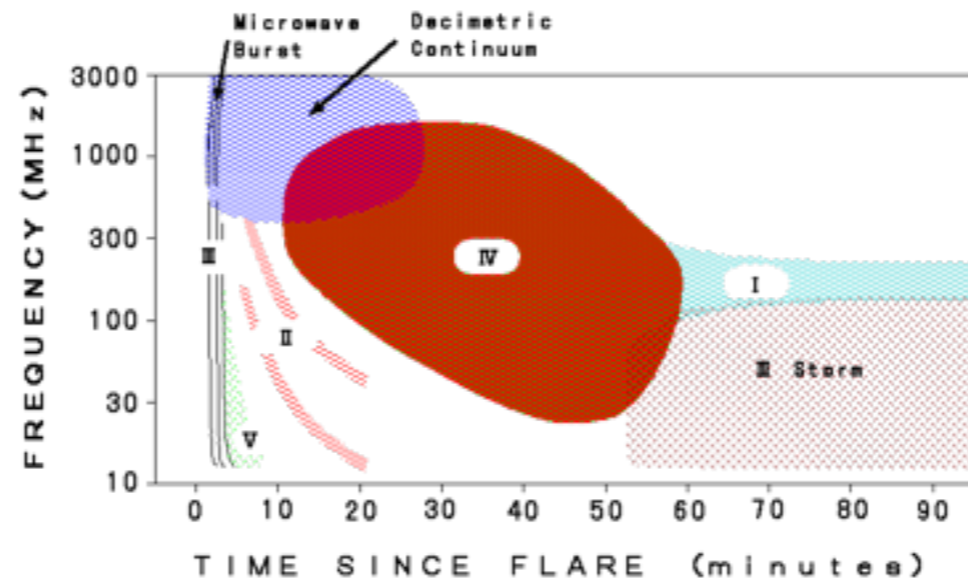
By making science accessible, we hope to reveal a new reality that was hidden up to now.

We will develop new methods

- that give a glimpse on the physical processes from **another point of view** and
- and that allows **a broader group** of people to interpret solar data.

such that research can profit from the strength of a group

Van Vitruvian



Understanding and refinement of the burst generation mechanism  
 - Tool to diagnose the solar corona - Long/short time & spatial scale behaviour? - Link with solar (sub-)surface processes? - Solar cycle dependence? - Signature of nanoflares?

what science is there to be found?

5 types of bursts

Triggered by a solar event, like a flare or plasma eruption. e.g. a shock can cause the local plasma to emit radio waves. While most of the interplanetary shocks are CME-driven, coronal shock waves can be attributed to solar flares, CMEs, or some combination of these two phenomena. Since the acceleration phase of the CME and the flare impulsive phase are usually closely synchronized, it is hard to distinguish between the flare energy-release effects and the CME expansion. Due to this problem the origin of the coronal shocks, i.e. metric type II bursts, still remains unresolved.

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Type IV

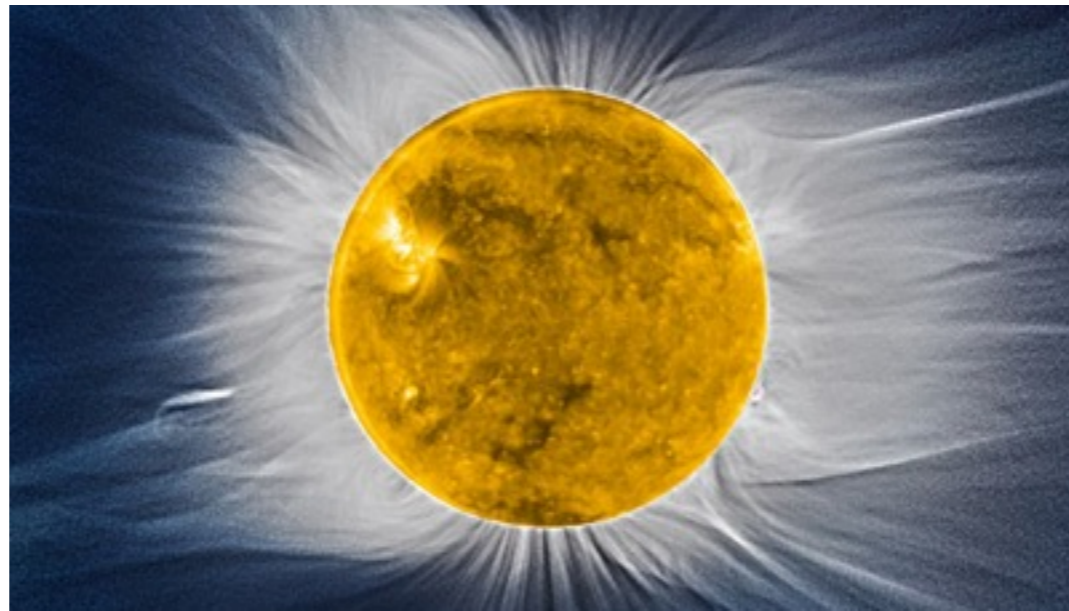
○ stationary type IV -- broadband continuum emission, sometimes highly polarized, due to either plasma emission (o-mode polarized) or gyrosynchrotron emission (x-mode polarized).

▪ cause is a plasmoid or high, filled loops of non-thermal particles



# PEPA IVANOVA

Expert in visualisation and sonification of data  
Talented in electronics and programming  
Without scientific prejudice - Broad artistic network



# SENSE THE SUN

Structures in the Sun's environment

SENSE THE SUN wraps culture and art around science trying to get more people concerned about and interested in science. The larger the concern and interest in science, the higher the tendency to invest in science.