

github.com/PaulJWright/DeepEM

DeepEM: A Deep Learning Approach to DEM Inversion

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Differential Emission Measure

Problem: Each extreme UV channel is sensitive to plasma at a range of temperatures.

To map the temperature of the Sun's corona, i.e. make maps of how much 1 million Kelvin plasma (or how much 10 million Kelvin plasma) exists in the corona, we need to disentangle the multi-thermal response of the telescopes channels from the inherently multi-thermal nature of the corona. This is called the differential emission measure (DEM) inversion problem.

DeepEM

Question: Can we train a neural network to give temperature maps similar (i.e. as scientifically useful as) solutions obtained from compressed sensing (basis pursuit)?

Simple multi-dimensional regression problem: Learn the mapping from **detector counts (x) to **differential emission measure (a.k.a. temperature) distribution (y)**.**

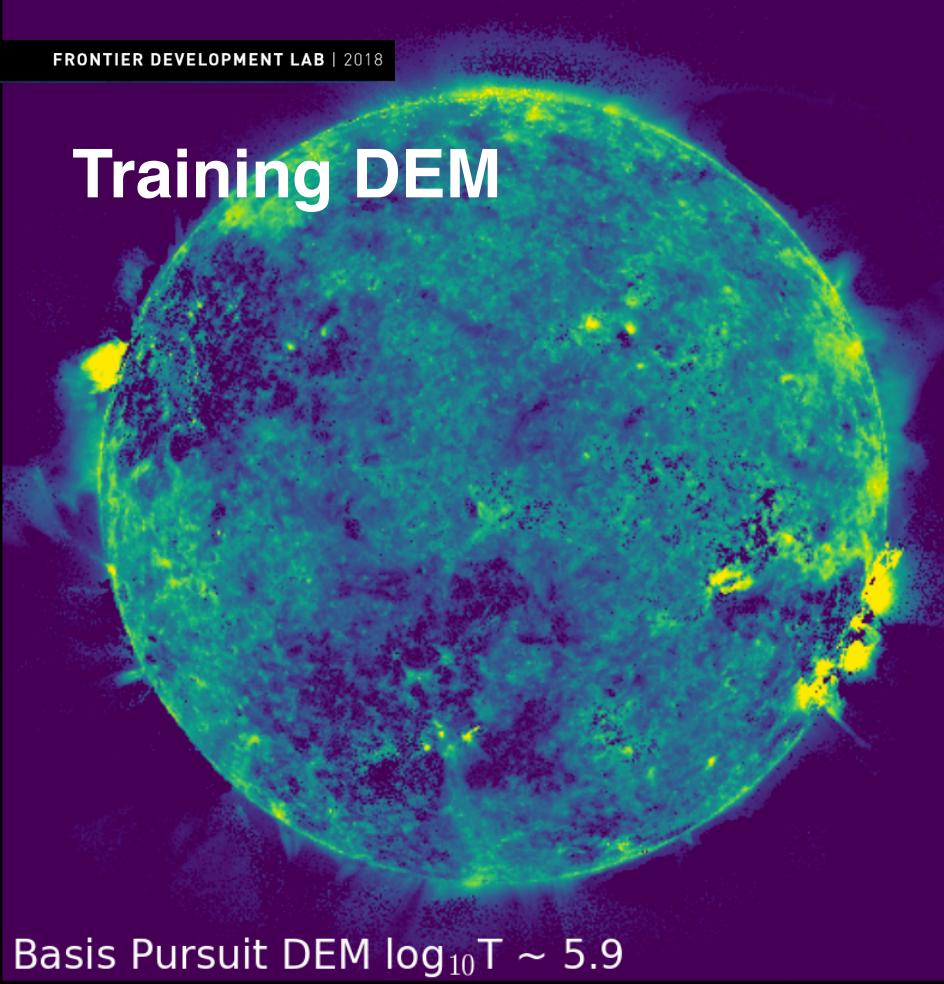
Important characteristics of inputs and outputs:

$$\mathbf{x}, \mathbf{y} \geq 0$$

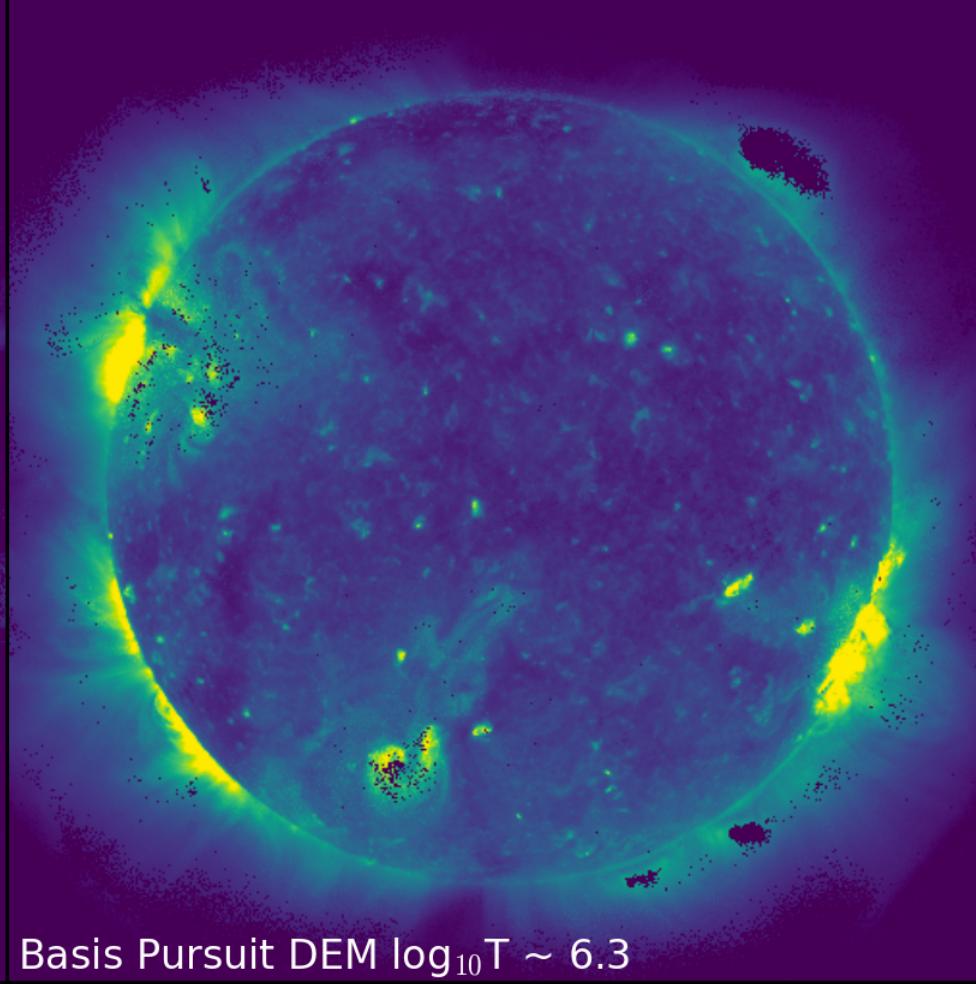
Due to high dynamic range, apply square-root scaling to **x** & **y**.

$$\dim(\mathbf{x}) \sim 6 < \dim(\mathbf{y}) \sim 18$$

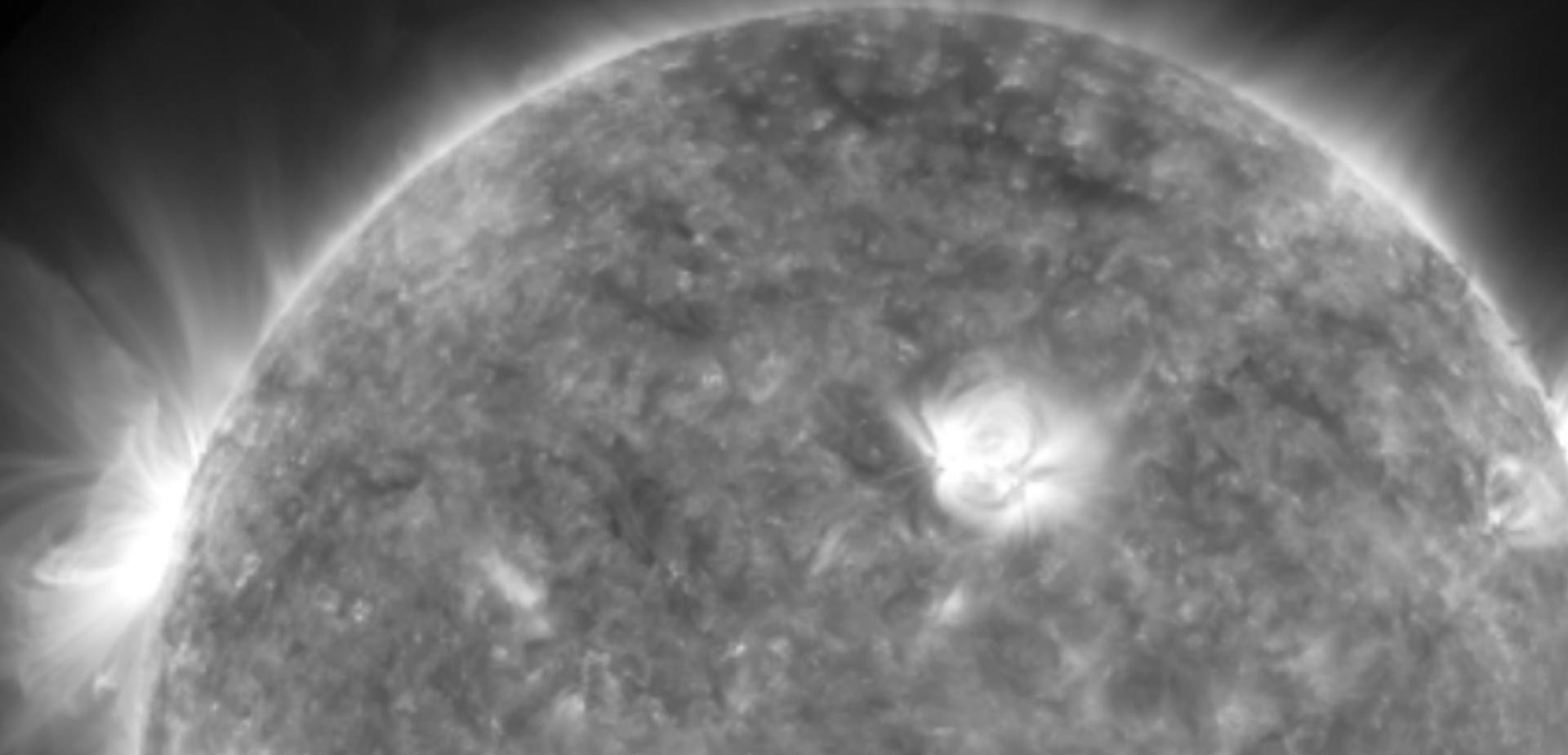
Training DEM



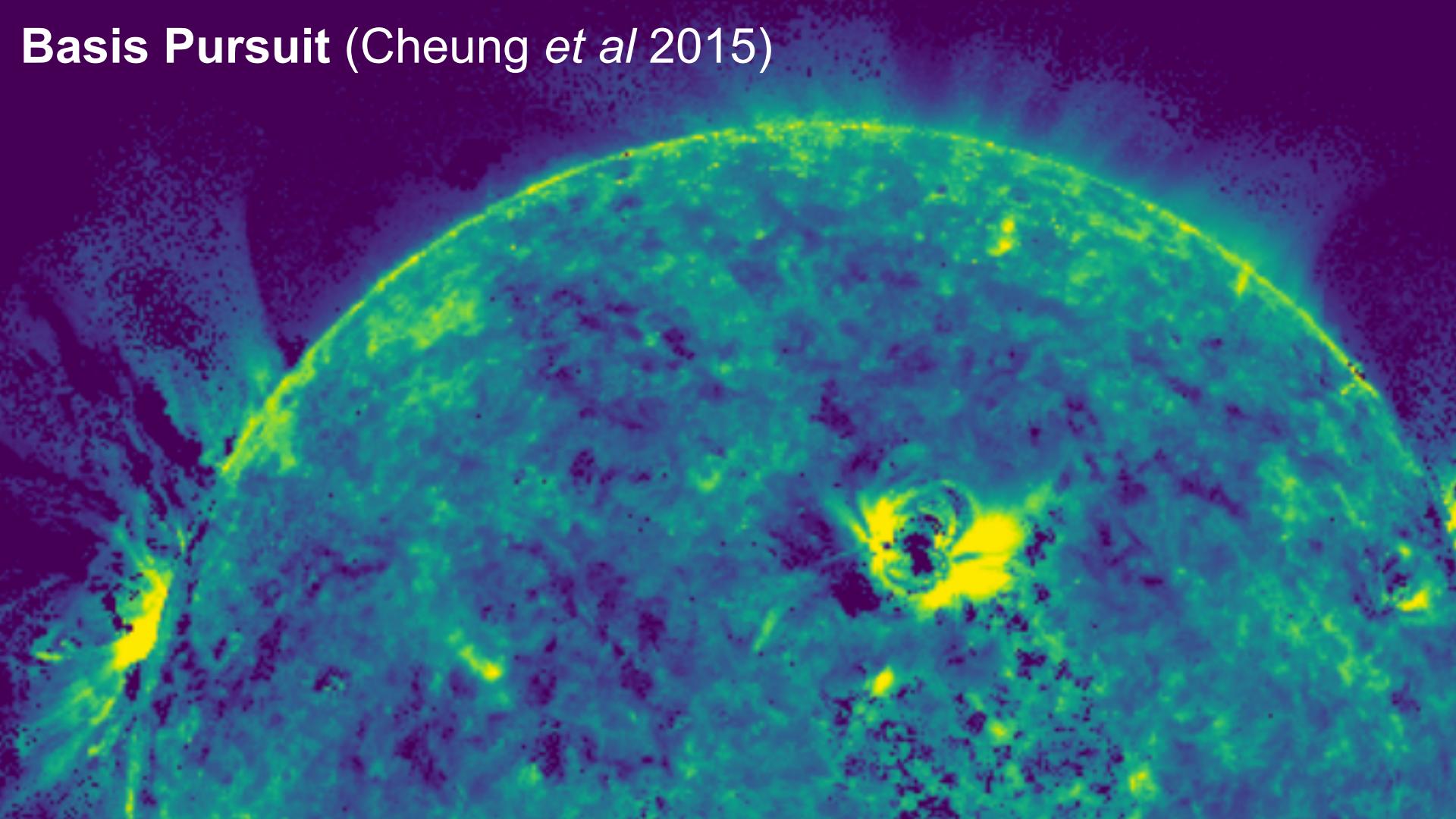
Basis Pursuit DEM $\log_{10} T \sim 5.9$



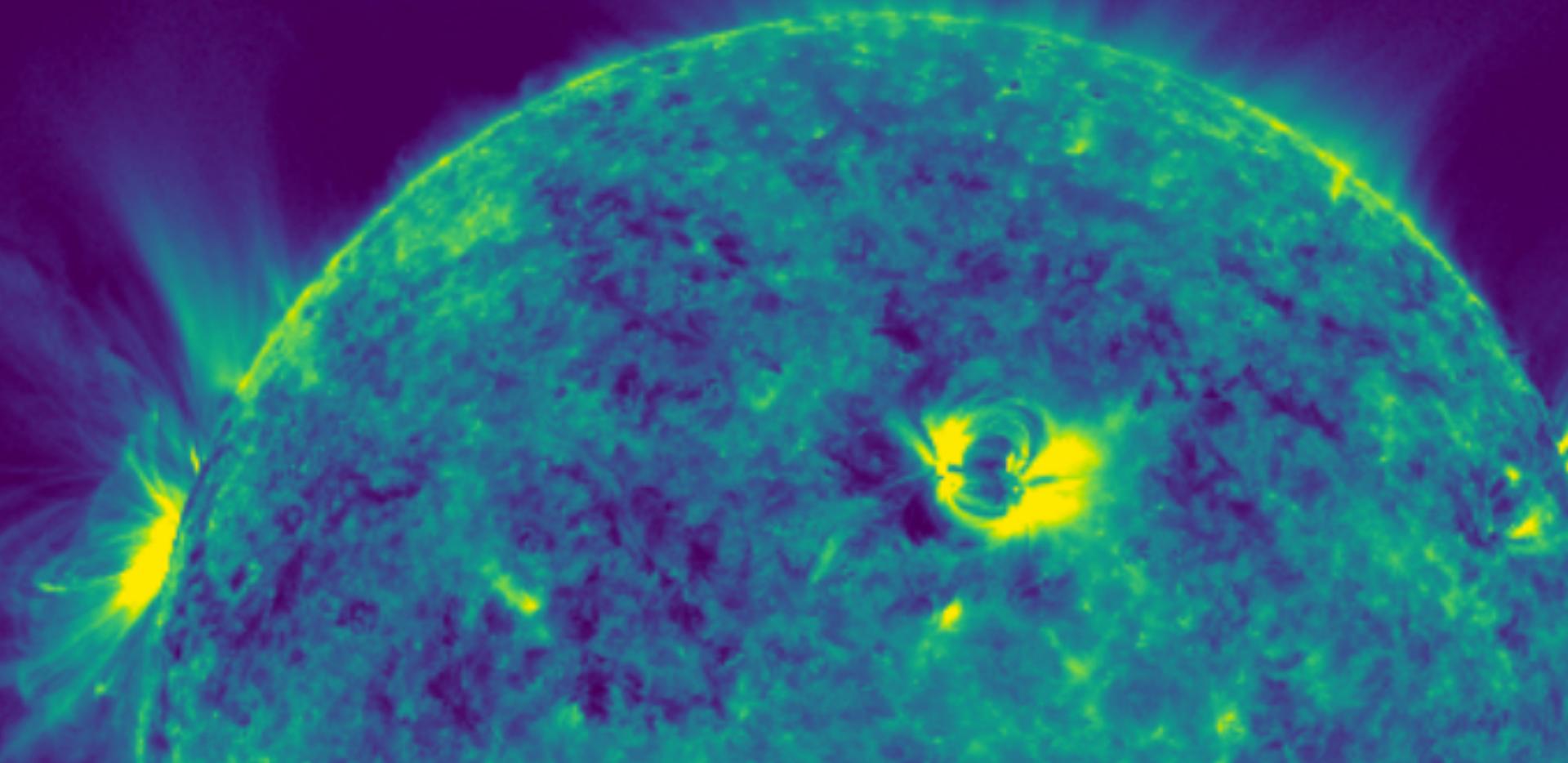
SDO/AIA 171 Å (Test)



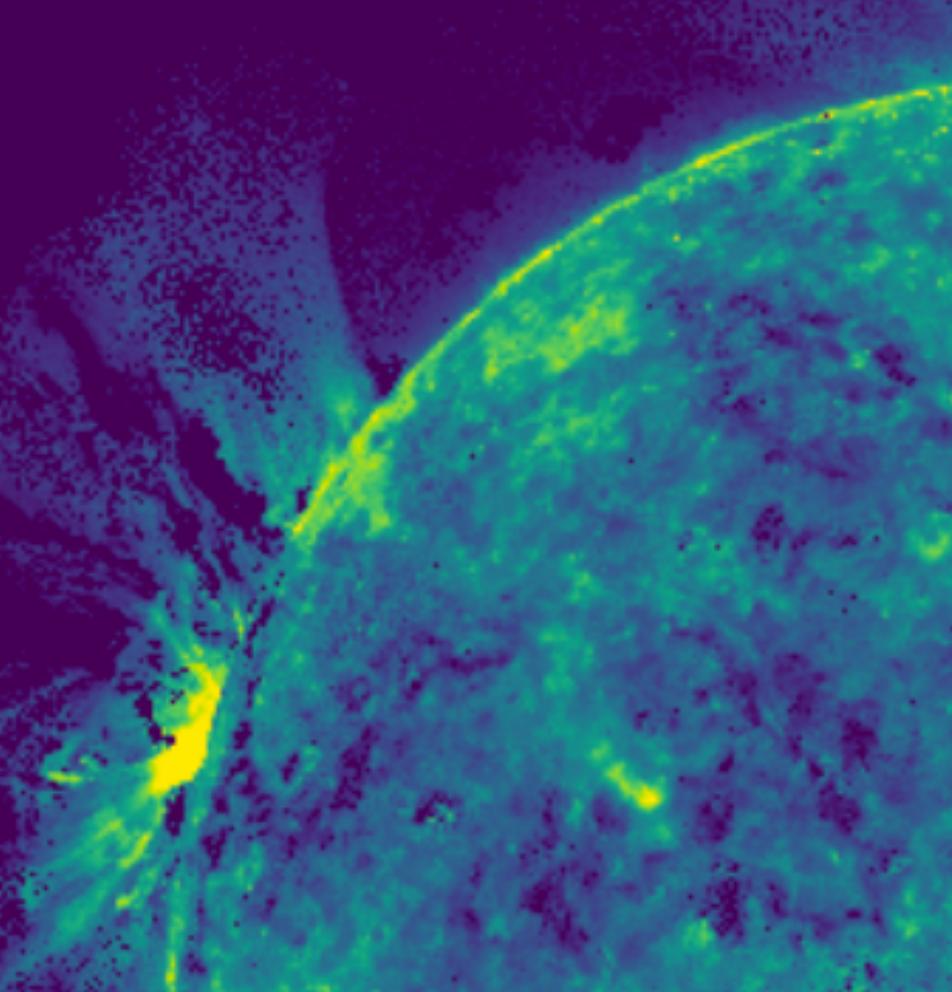
Basis Pursuit (Cheung *et al* 2015)



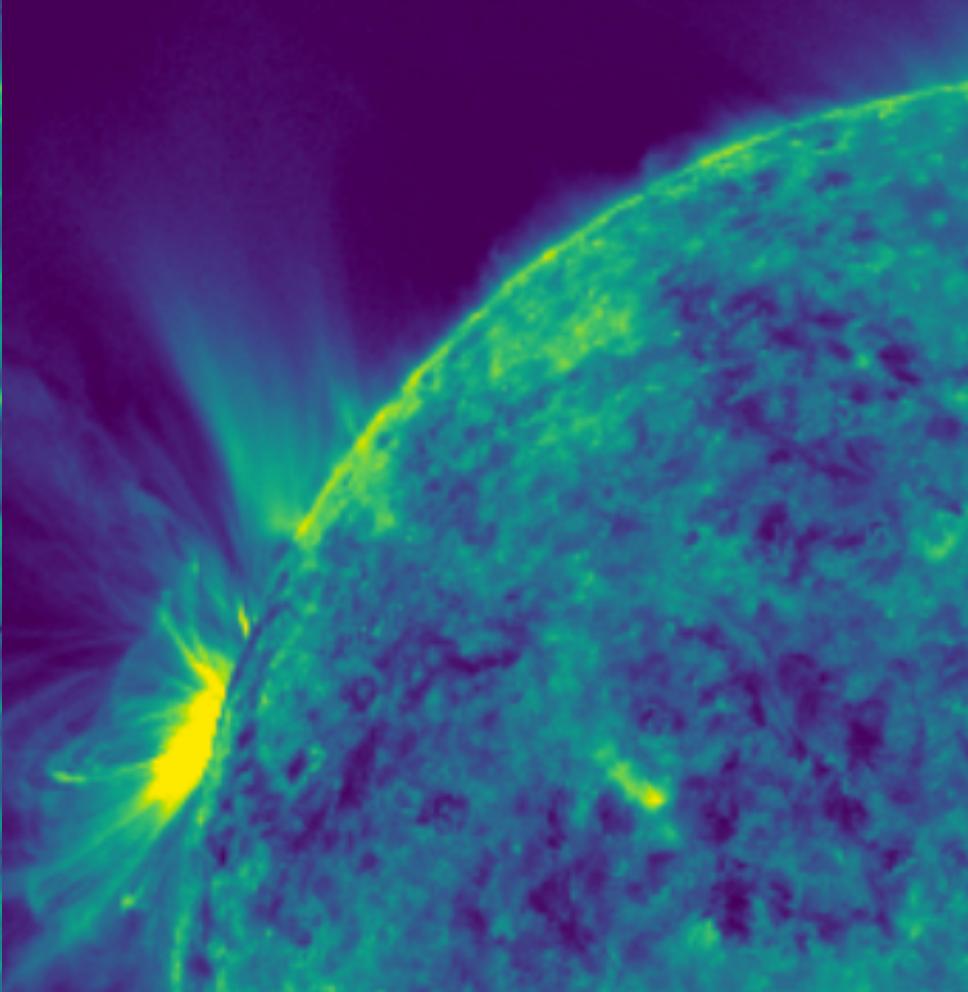
DeepEM: (Wright *et al* in prep.)



Basis Pursuit (Cheung *et al* 2015)



DeepEM (Wright *et al* in prep.)



DeepEM Notebook

Simplified DeepEM code is to appear in HelioML (Bobra & Mason) <https://helioML.github.io/HelioML>

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