Treasure Hunting in the Spectra Database of the Sloan Digital Sky Survey using Kohonen Self-Organising Maps

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Sloan Digital Sky Survey (SDSS)

Data Release 12 (Alam et al. 2015, ApJS 219,12)

Optical imaging

- 5-band photometry: 469 million objects

Spectroscopy

- useful spectra: 4.3 million

The Search for a Needle in a Haystack

Automated SDSS spectroscopic pipeline

Works fine for vast majority

… but tends to fail for unusual, rare spectra!

The Search for a Needle in a Haystack

Visual inspection of 5 million spectra

Assume:

- 10 sec per spectrum
- 5 hours per day (without a break)
- 5 days per weak
- no holidays, no vacations

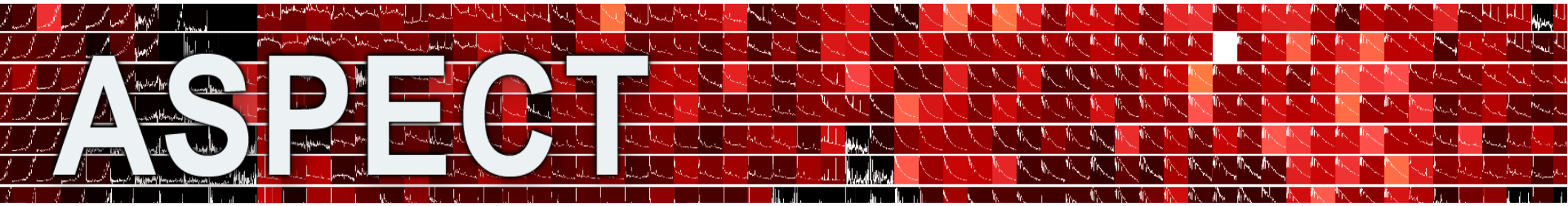
➡ 11 years !!!

The Search for a Needle in a Haystack

Our approach: ASPECT

Software package that

- computes Kohonen self-organizing maps (SOMs)
- i.e., projects spectra onto a 2-dimensional map
- ... where they are sorted („clustered“) by similarity



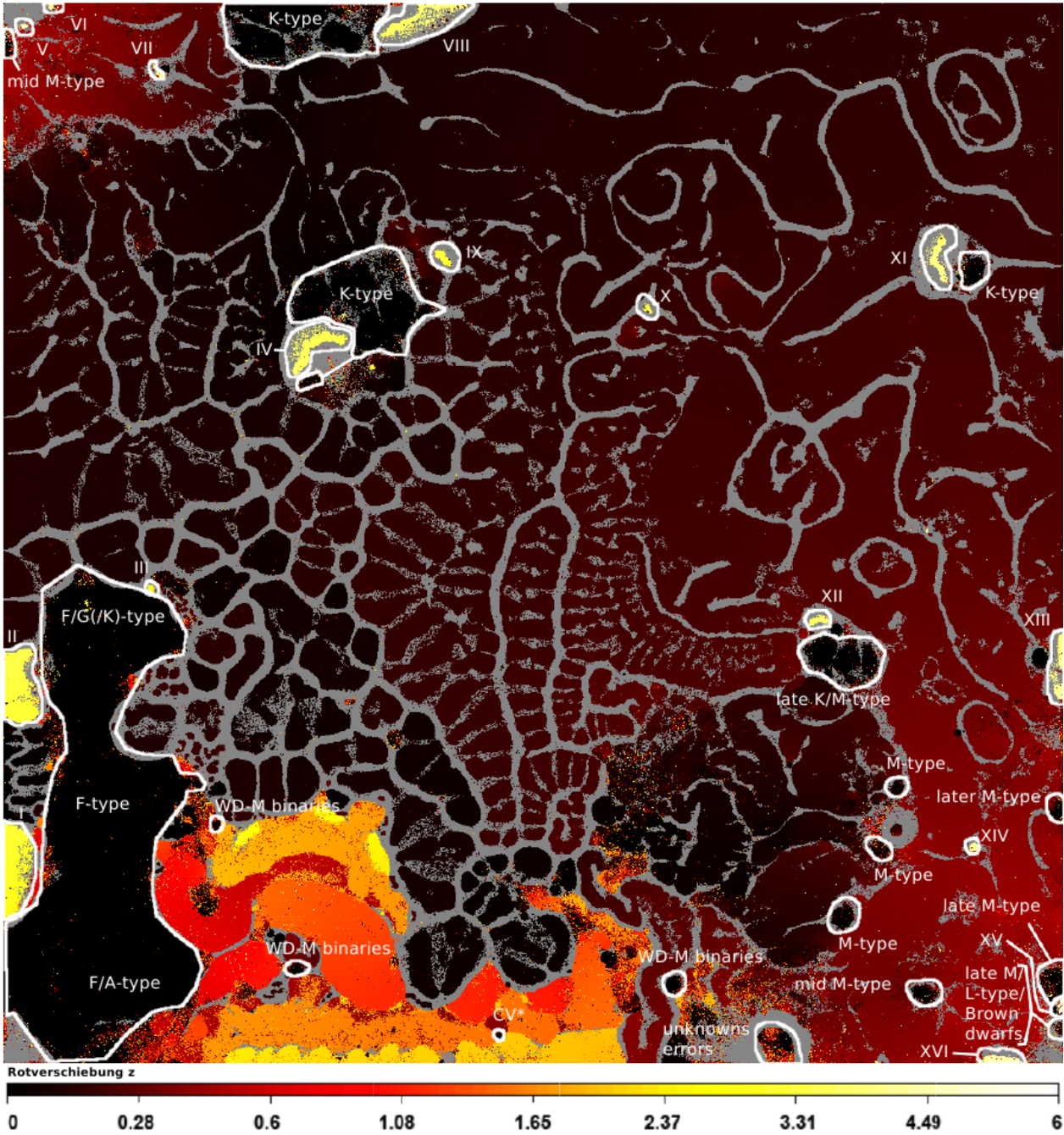
www.tls-tautenburg.de/TLS/fileadmin/forschung/meus/ASPECT/ASPECT.html

Sorting SDSS Spectra with ASPECT

Largest SOM (so far)

1 million spectra from SDSS DR7 *

- 200 iterations
- Colour coding:
  redshift: black-yellow
  grey: empty neurons

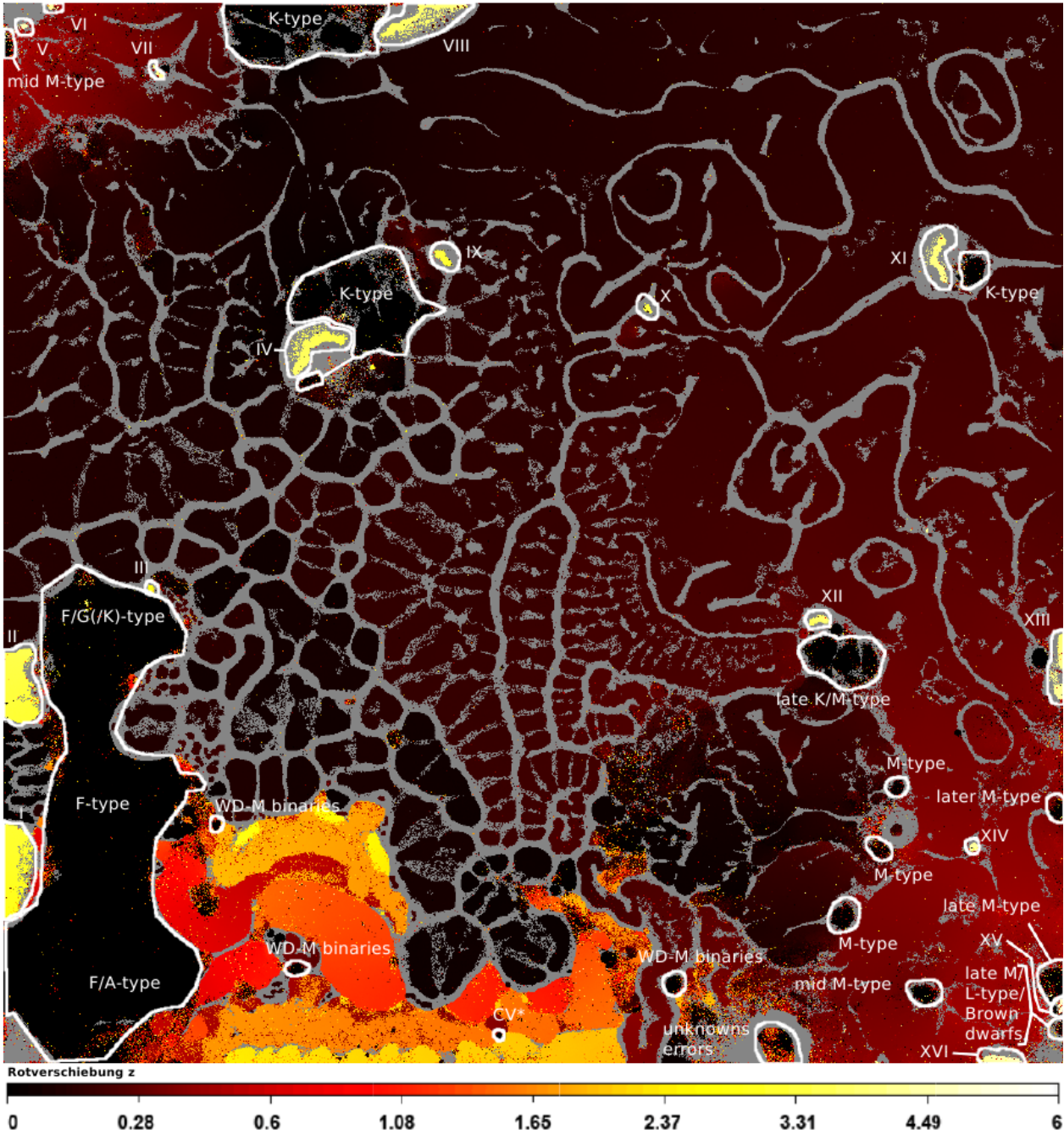


Sorting SDSS Spectra with ASPECT

Representation types

(A) z map

colour represents redshift



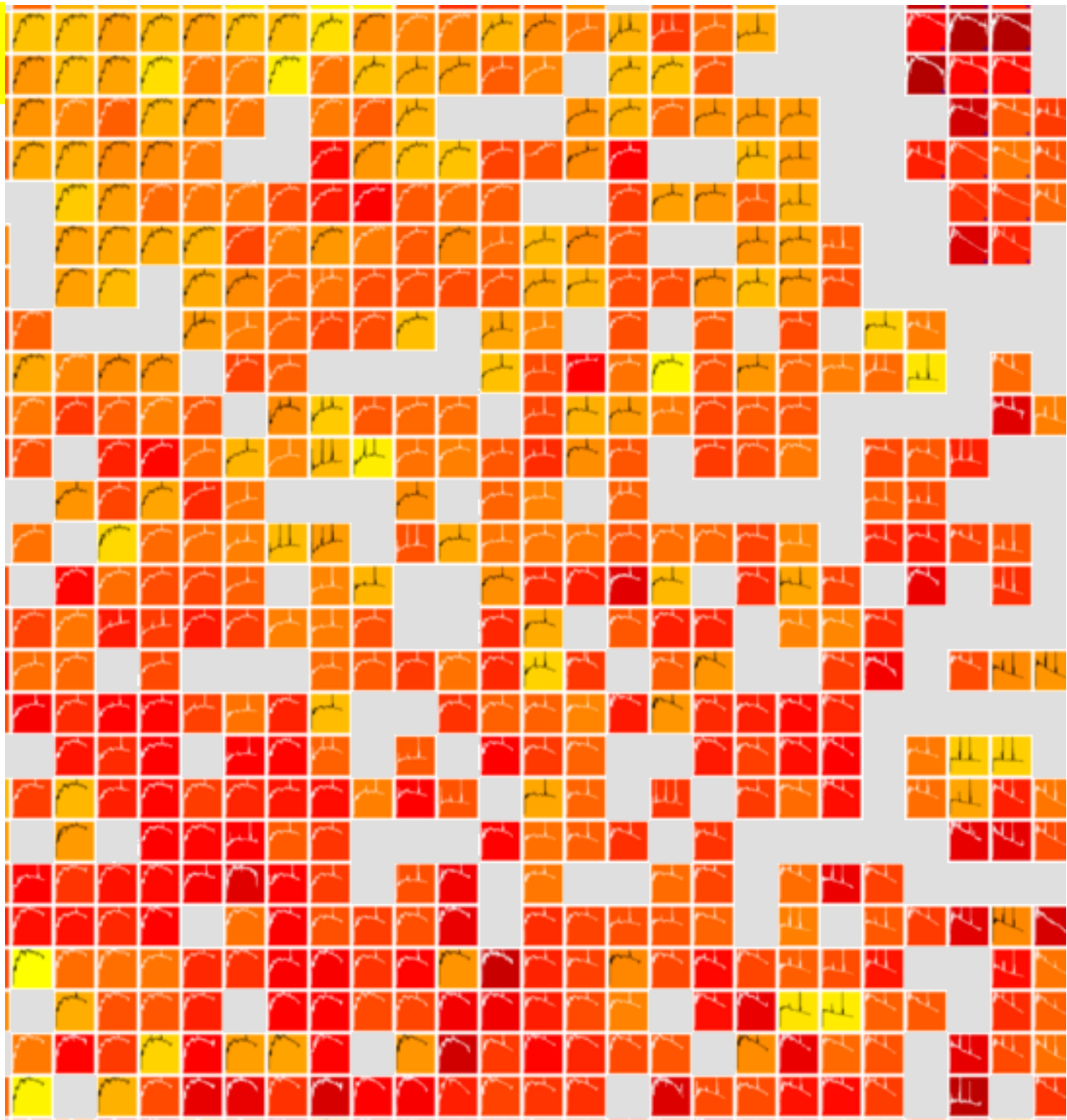
Sorting SDSS Spectra with ASPECT

Representation types

(B) Icon map

each pixel is represented by the spectrum itself ...

… and is linked to the archive server of the SDSS.



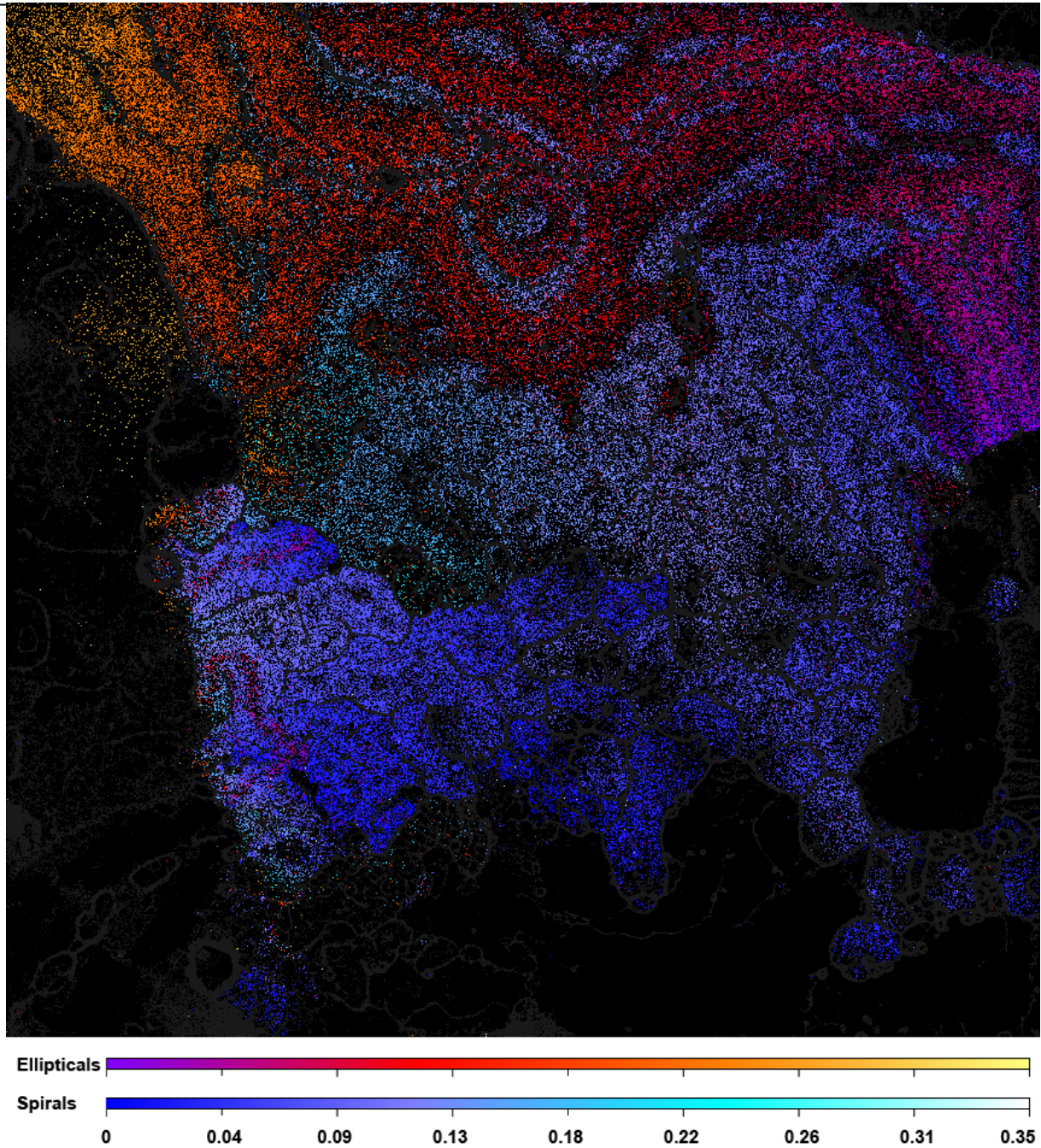
Sorting SDSS Spectra with ASPECT

Representation types

(C) Blending in other data
(e.g. from external archives)

Useful to illustrate general trends.

Example:
morphological galaxy types from the GalaxyZoo project



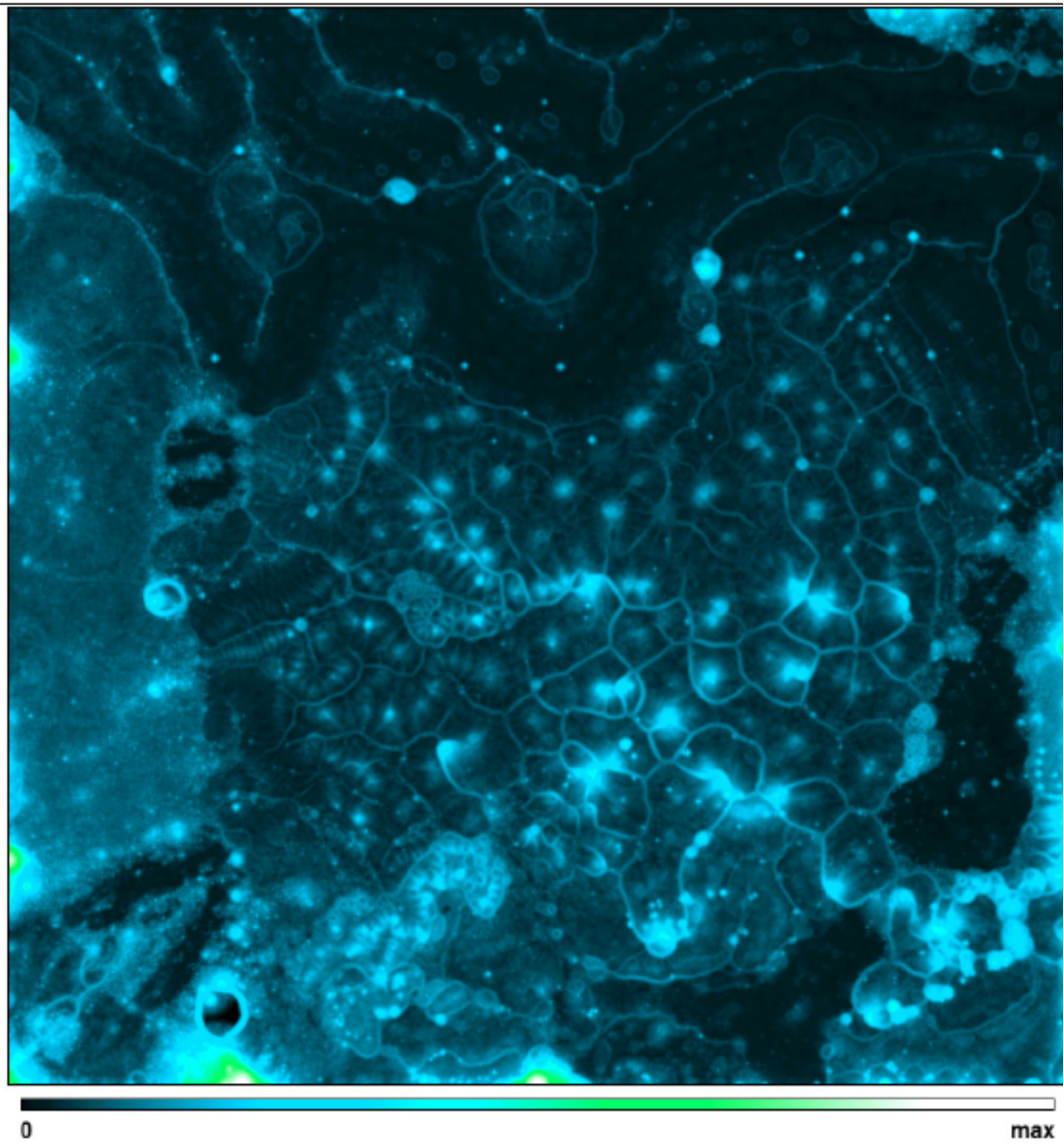
Sorting SDSS Spectra with ASPECT

Representation types

(D) Local difference map

indicates relative dissimilarity

useful for search for outsiders



Scientific Applications of ASPECT

Selection of rare spectral types

- various types of unusual quasars
- weak-emission line quasars
- 3000 Å break quasars
- post-starburst galaxies
- carbon white dwarfs (DQs)
- supernovae