Digital Image Processing

Doç. Dr. Mehmet Serdar Güzel

Slides are mainly adapted from the following course page:
http://www.comp.dit.ie/bmacnamee

Lecturer

- Instructor: Assoc. Prof Dr. Mehmet S Güzel
  - Office hours: Tuesday, 1:30-2:30pm
  - Open door policy – don’t hesitate to stop by!
- Watch the course website
  - Assignments, lab tutorials, lecture notes

PIXEL BASED SPECTRUM ANALYSIS FROM HYPERSPECTRAL AIRBORNE IMAGE

A Case Study

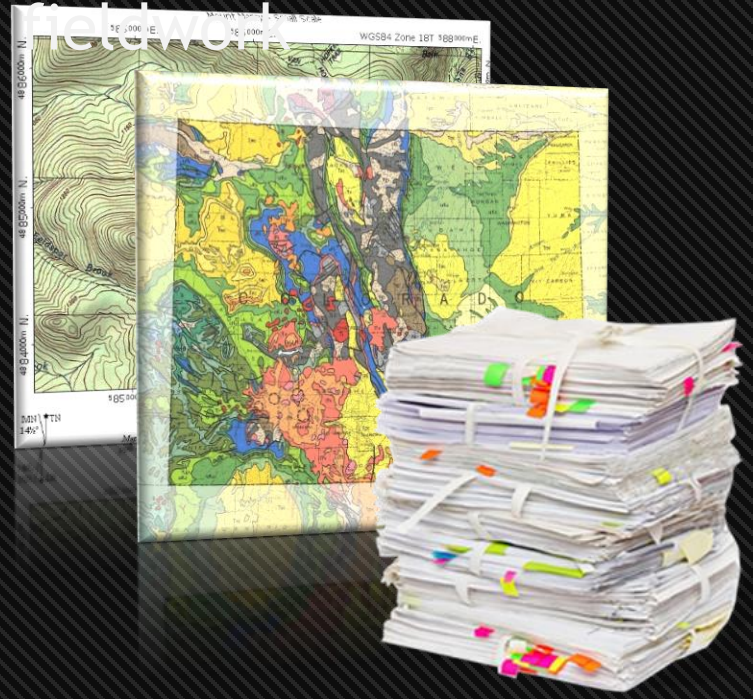
By Çağrı TUNCA[1], Agah GÜRER[1,2]

(1) Earth Sciences Research and Application Center (YEBIM), Department of Geological Engineering, Ankara University, TURKEY

(2) General Directorate of Mineral Research and Exploration, Ankara, TURKEY

Classic Observation Methods in Earth and Enviromental Sciences

Step 1: Preliminary fieldwork



Step 2.1 : Actual Fieldwork

Classic Observation Methods in Earth and Enviromental Sciences

Step 2.2: Sampling

Step 3: Laboratory Analysis

How much does it cost?

LABOR – TIME

- Excessive preliminary literature work
- Long hours of field work and unnecessary reporting of irrelevant subjects
- Up to dozens of time field trips
- Need a huge amount of human labor

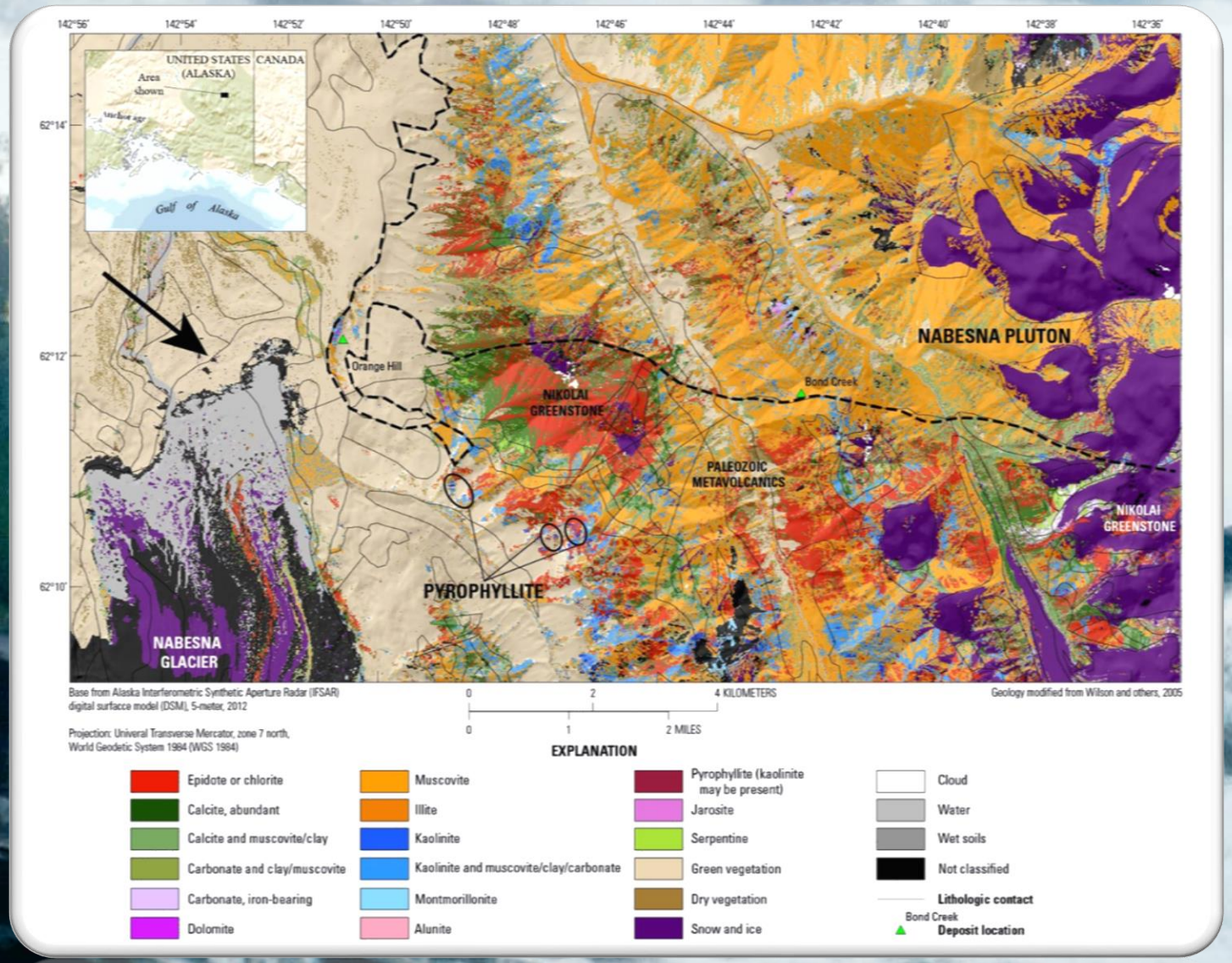
AVERAGE COST: **2 hour/$_{1000\ m^2}$**

MONEY

- Transportation and accommodation outcomes
- Sampling instruments
- Laboratory expenses

AVERAGE COST: **150-50k \$/$_{1000\ m^2}$**

How much does it cost?



- **20** km^2 survey area
- Rough and dangerous terrain
- Multiple riverbed
- Hard to reach remote location

- Only **3** to **6** km2 area of interest
- **%80** excessive cost (time & money)

Multispectral image

From Wikipedia, the free encyclopedia

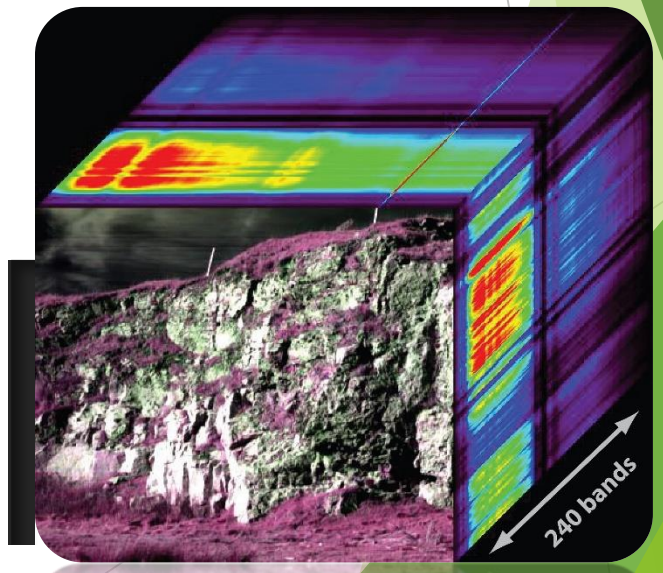
A **multispectral image** is one that captures image data within specific wavelength ranges across the electromagnetic spectrum. The wavelengths may be separated by filters or by the use of instruments that are sensitive to particular wavelengths, including light from frequencies beyond the visible light range, i.e. infrared and ultra-violet. Spectral imaging can allow extraction of additional information the human eye fails to capture with its receptors for red, green and blue. It was originally developed for space-based imaging,[1] and has also found use in document and painting analysis.

Multispectral imaging measures light in a small number (typically 3 to 15) number of spectral bands. Hyperspectral imaging is a special case of spectral imaging where often hundreds of contiguous spectral bands are available.[2]

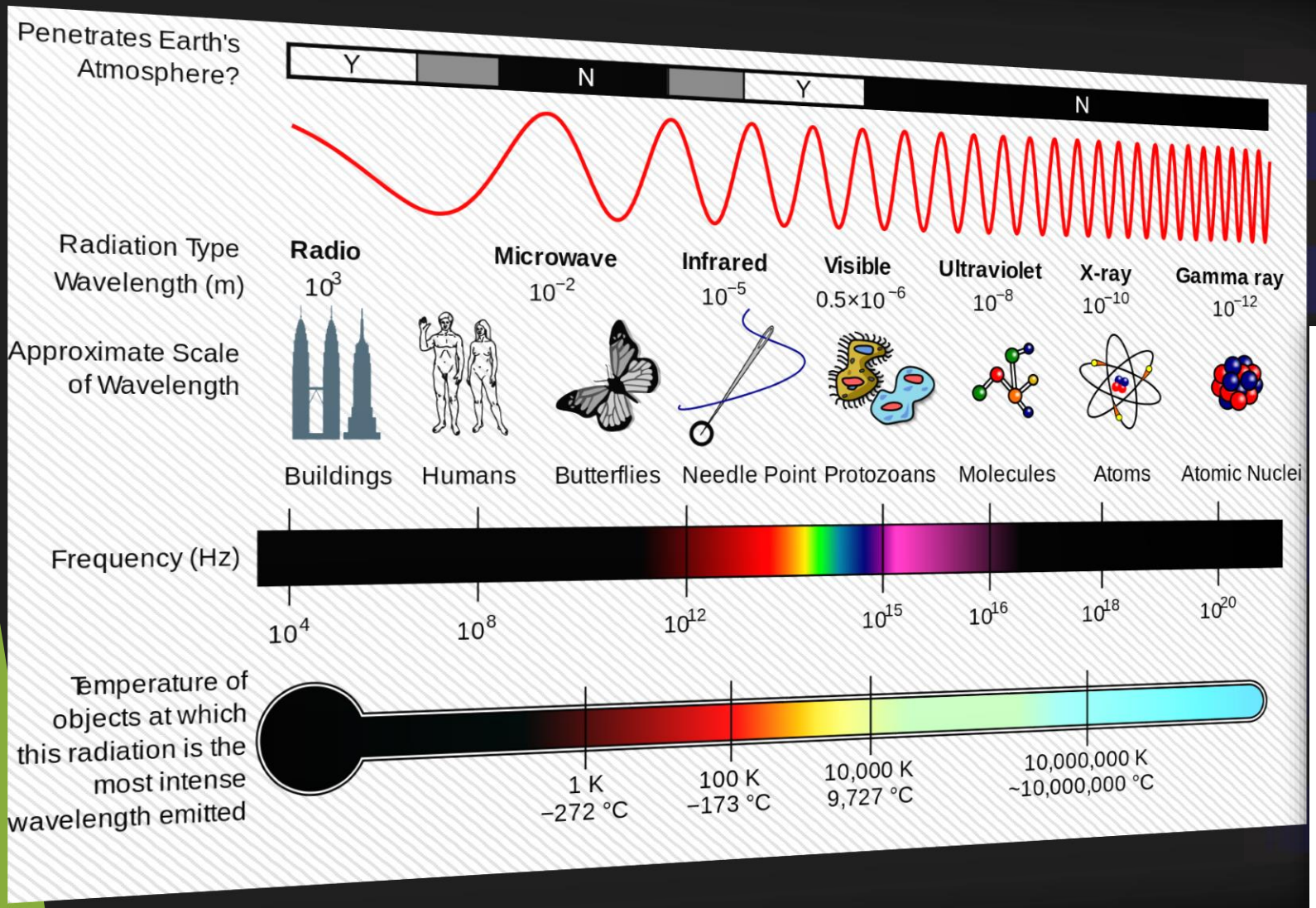
Hyperspectral imaging

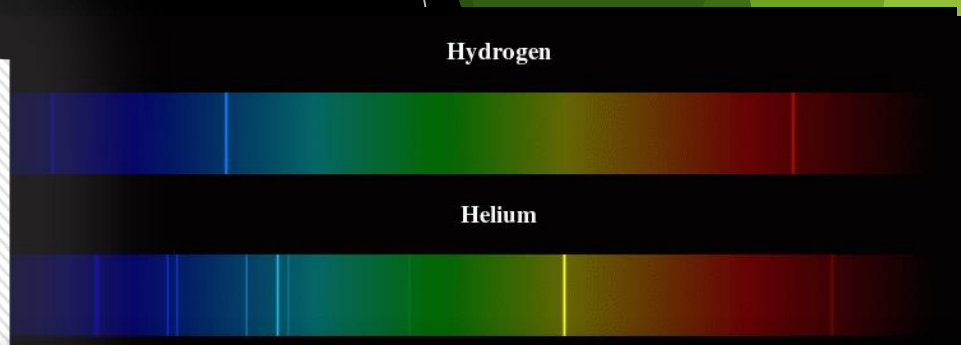
From Wikipedia, the free encyclopedia
(Redirected from Hyperspectral)

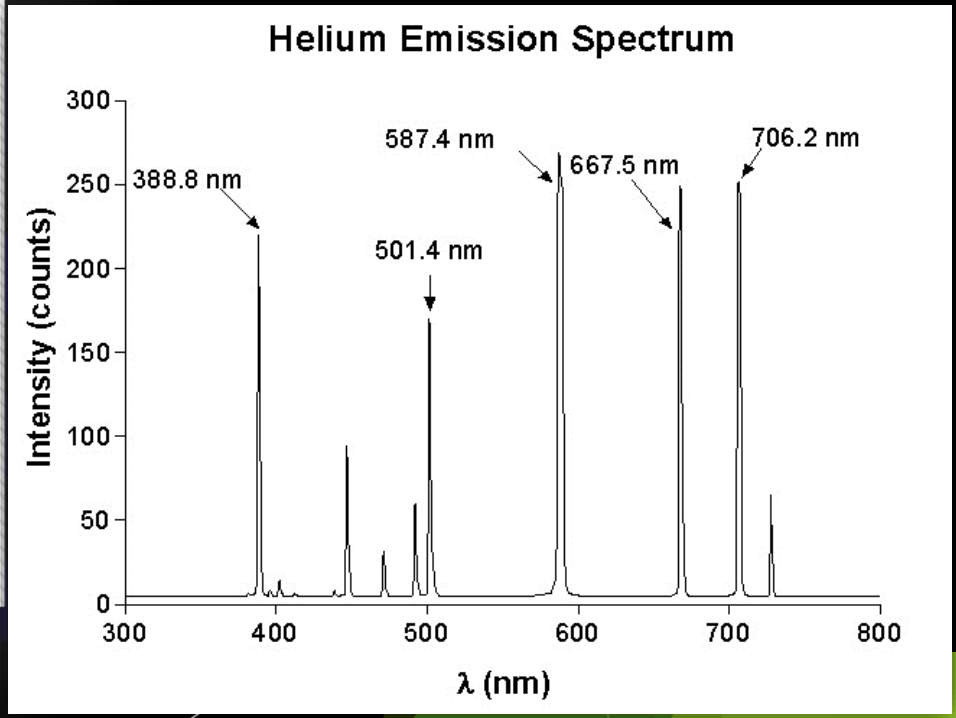
Hyperspectral imaging, like other spectral imaging, collects and processes information from across the electromagnetic spectrum. The goal of hyperspectral imaging is to obtain the spectrum for each pixel in the image of a scene, with the purpose of finding objects, identifying materials, or detecting processes.[1][2] There are two general branches of spectral imagers. There are push broom scanners and the related whisk broom scanners, which read images over time, and snapshot hyperspectral imaging, which uses a staring array to generate an image in an instance.



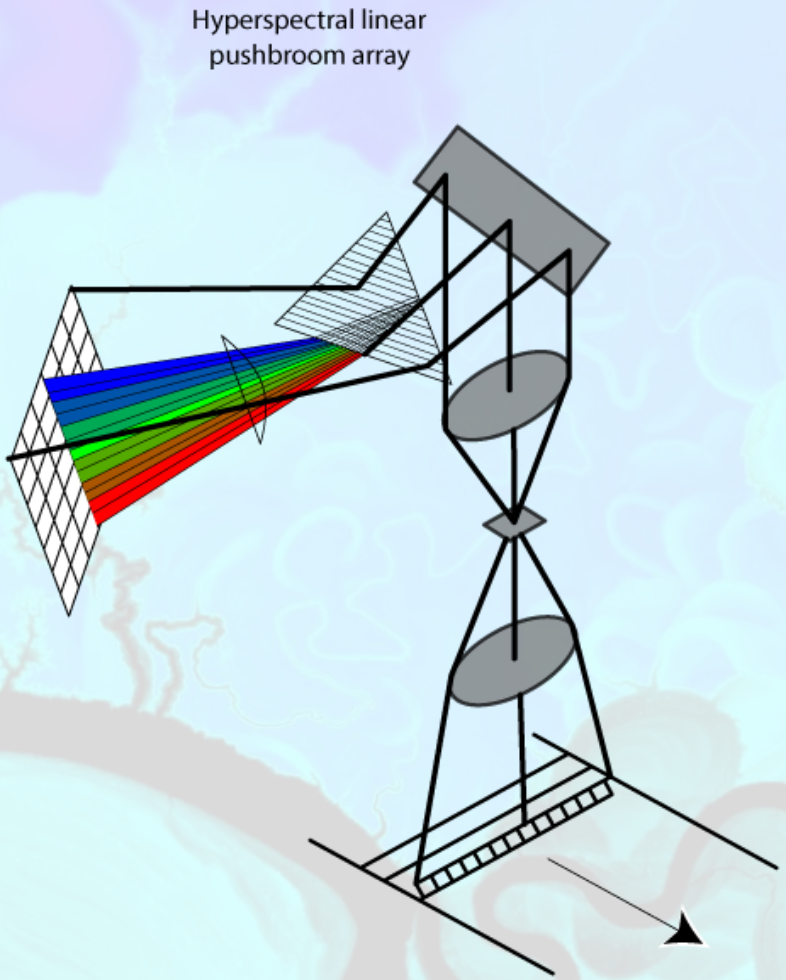
HOW
is it
possible

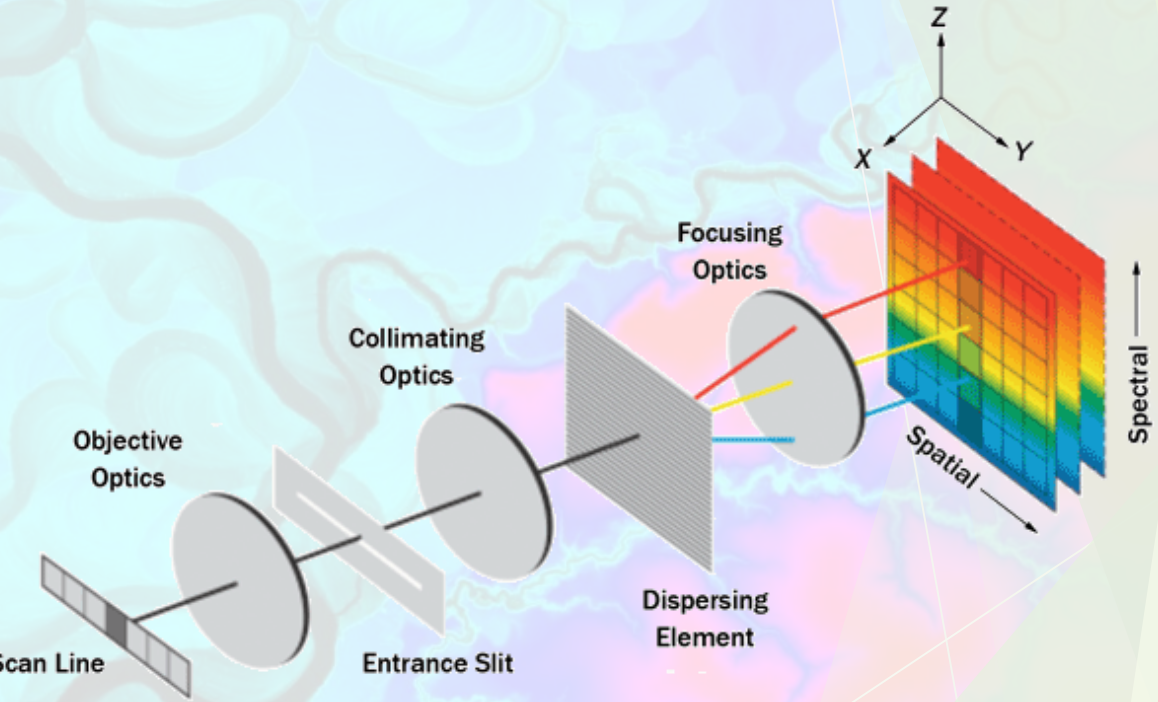

Penetrates Earth's Atmosphere?
Y
N
Y
N
Radiation Type
Wavelength (m)
Radio
10^{3}
Microwave
10^{-2}
Infrared
10^{-5}
Visible
0.5×10^{-6}
Ultraviolet
10^{-8}
X-ray
10^{-10}
Gamma ray
10^{-12}
Approximate Scale of Wavelength
Buildings
Humans
Butterflies
Needle Point
Protozoans
Molecules
Atoms
Atomic Nuclei
Frequency (Hz)
10^{4}
10^{8}
10^{12}
10^{15}
10^{16}
10^{18}
10^{20}
Temperature of objects at which this radiation is the most intense wavelength emitted
1 K
−272 °C
100 K
−173 °C
10,000 K
9,727 °C
10,000,000 K
~10,000,000 °C


Hydrogen
Helium

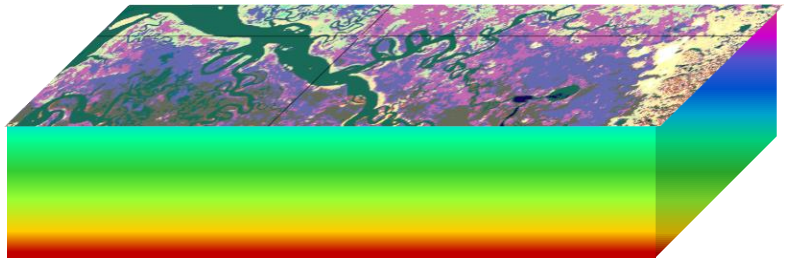

Helium Emission Spectrum
Intensity (counts)
λ (nm)
388.8 nm
501.4 nm
587.4 nm
667.5 nm
706.2 nm
0
50
100
150
200
250
300
300
400
500
600
700
800

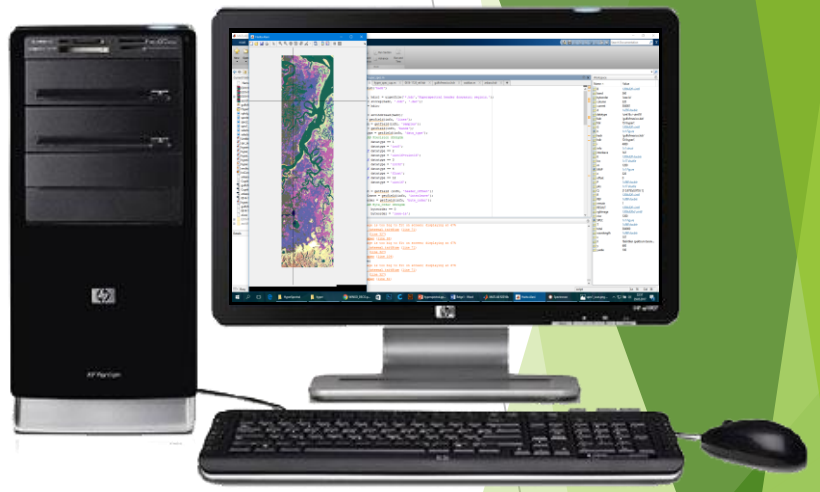
How hyperspectral imaging works?

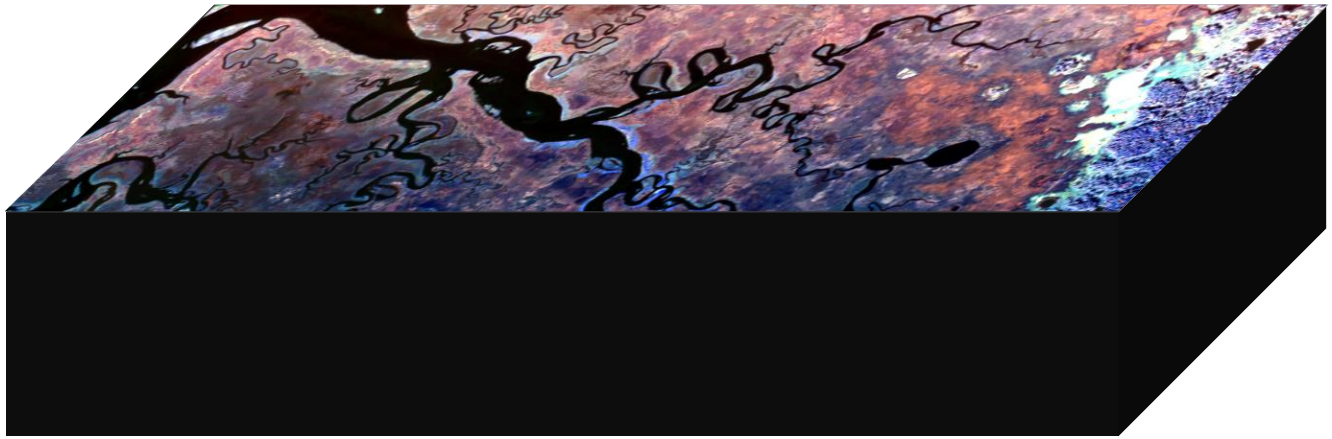


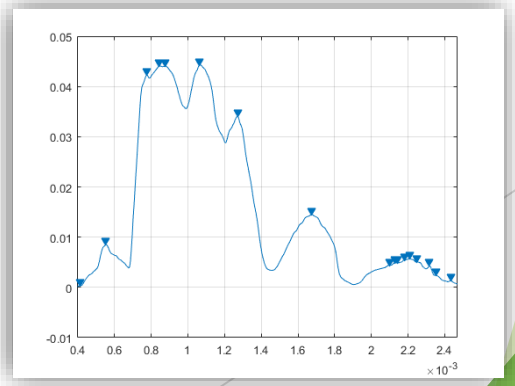


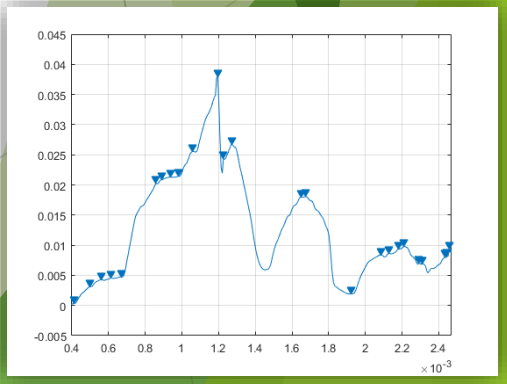
What to do?








0.05
0.04
0.03
0.02
0.01
0
-0.01
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
×10^-3


0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
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-0.005
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
×10^-3

Band 0 – 326 nm

Band 10 – 434 nm

Band 35 – 547 nm

Band 45 – 594 nm

Band 50 – 617 nm

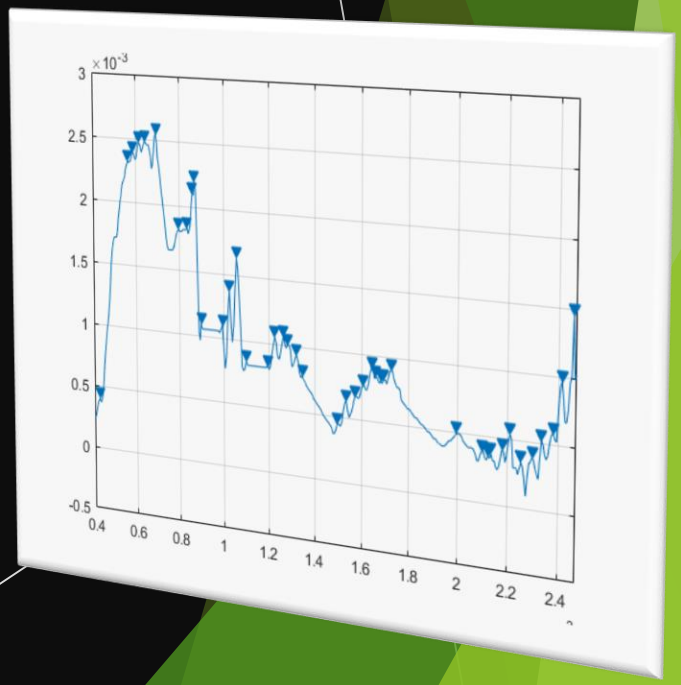
Band 65 – 687 nm

Band 72 – 720 nm

Band 83 – 772 nm

Band 94 – 825 nm

10 x 0 pixel all bands



Band 0 – 326 nm

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Band 65 – 687 nm

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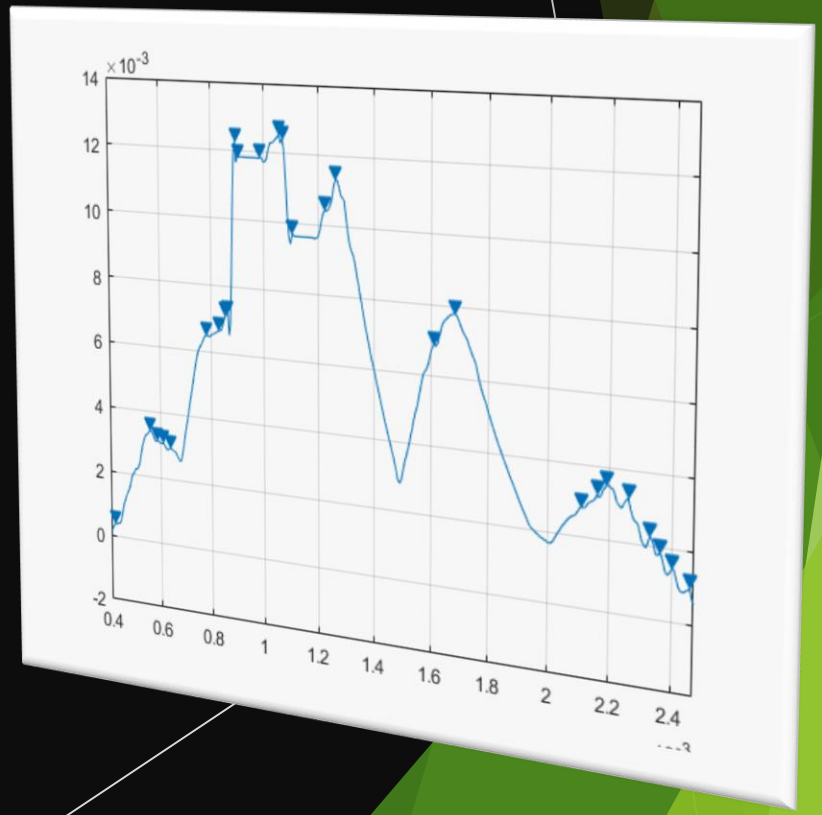
Band 94 – 825 nm

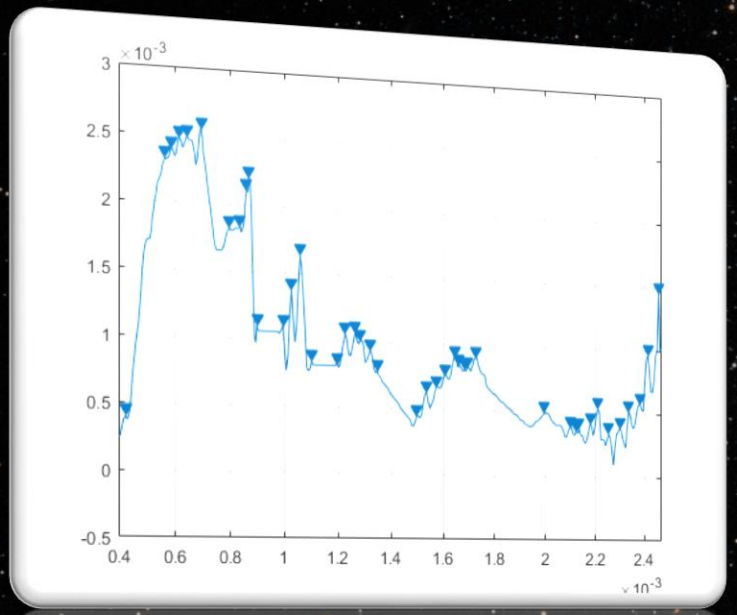
16	14	10	9	9	10	8	9	10	11	
14	28	26	29	27	29	29	31	28	48	54
15	26	144	143	143	147	150	153	157	164	298	357
15	30	142	154	151	156	156	161	167	170	177	280	339
15	39	154	153	161	162	162	166	168	174	177	185	273	337
16	58	237	172	164	165	164	165	170	174	176	184	201	279	366
15	67	378	252	175	165	135	133	131	137	142	144	152	172	736	974
16	58	432	373	251	178	128	109								117	158
14	44	384	402	370	257	158	106	119	117	110	121	121	124	131	172	1245	1695
14	38	341	358	396	374	397	144	111	113	112	119	118	124	132	197	1448	1752
15	37	303	320	347	393	872	534	149	320	195	126	118	123	139	251	1730	1735
13	34	293	291	316	340	1088	1344	542	1066	449	162	136	130	147	261	1749	1726
15	31	288	278	293	318	1033	1774	1433	1497	419	158	137	139	145	353	1800	1735
14	37	289	274	281	300	975	1691	1892	1108	266	147	136	140	152	457	1892	1737
16	36	308	276	271	294	927	1624	1778	660	135	137	136	130	138	444	1965	1768
14	37	327	294	278	284	911	1536	1705	631	188	141	189	201	149	324	1966	1761
17	40	348	307	294	290	901	1531	1614	600	192	152	496	68	233	41	1793	1694
15	54	367	321	307	305	918	1515	1615	684	218	191	972	1712	690	2	118	1668
	50	391	344	325	315	949	1545	1612	700	415	398	1492	2269	1170	320	551	
		405	363	338	330	984	1597	1648	772	1013	912	1906	2192	1468	689	281	119
			383	360	349	1000	1641	1709	1130	1516	1213	1874	2030	1826	1279	477	698
				378	371	1016		174	154	189	117	172	200	185	154		
					390												

10 x 18 pixel all bands



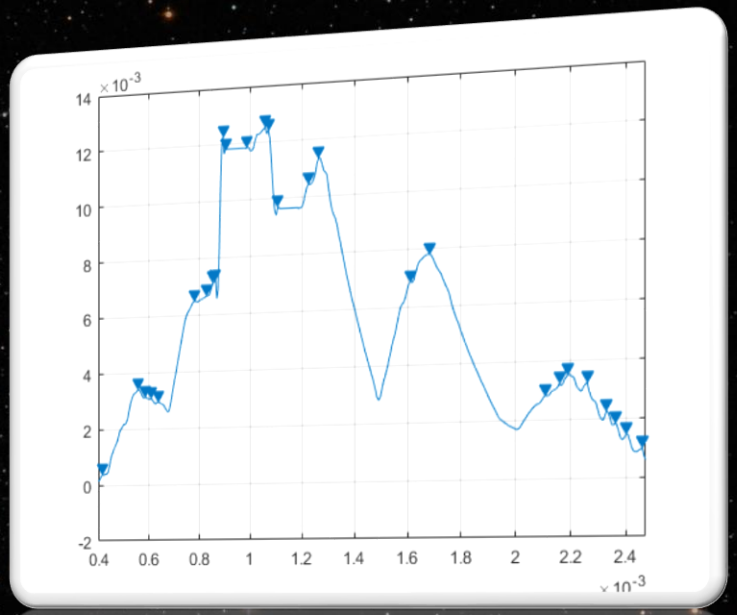
Spectrum Comparison

10 x 0 pixel spectrum



VS

10 x 18 pixel spectrum



Correlation Coefficient

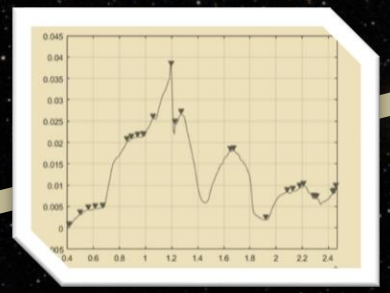
corrcoef = ?

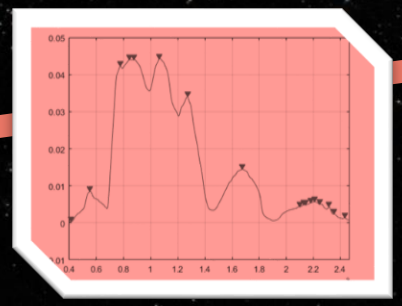
Spectrum Comparison

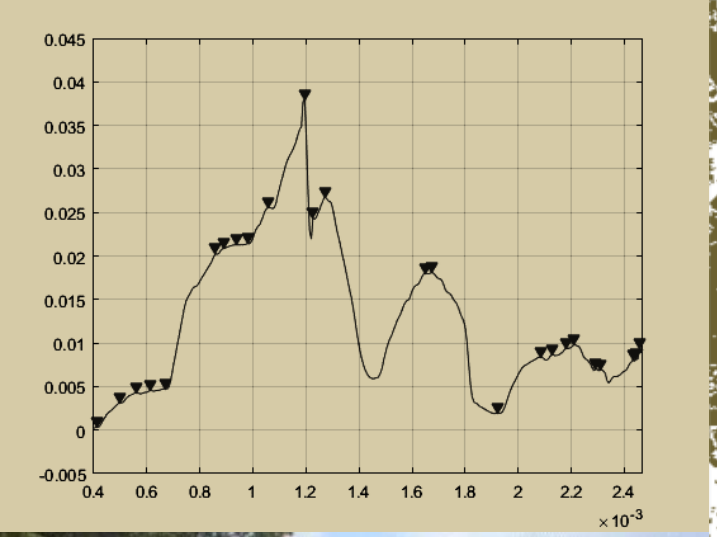
Correlation Coefficient (0 – 1)
«corrcoef»

similarity(x,y) = ***corrcoef*** ** 255*

62	62	60	66	68	70	71	79	105	115
62	63	64	64	68	67	72	75	107	118
64	67	64	66	69	68	72	77	121	123
85	94	70	71	68	71	71	77	123	128
118	110	76	63	68	70	67	81	123	119
134	107	70	69	70	71	72	83	129	126
118	79	67	64	67	69	74	85	136	136
101	77	64	67	68	68	73	84	136	137
99	71	66	65	77	83	67	76	141	143
88	75	68	68	93	110	83	74	132	163
89	69	76	76	107	126	94	76	107	162
88	78	87	82	124	133	103	82	84	151
93	82	100	84	131	131	117	101	81	119
93	81	101	82	119	135	131	112	96	108
101	89	105	88	123	135	127	110	113	106
103	97	112	94	123	144	135	115	116	104
114	111	115	98	124	147	142	119	112	84
115	117	114	108	135	146	148	124	113	83



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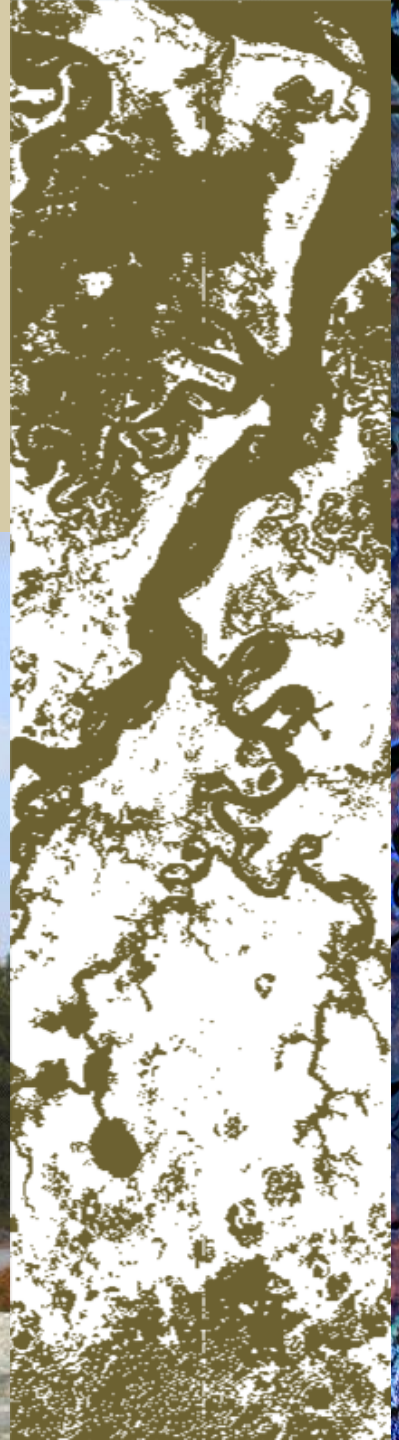
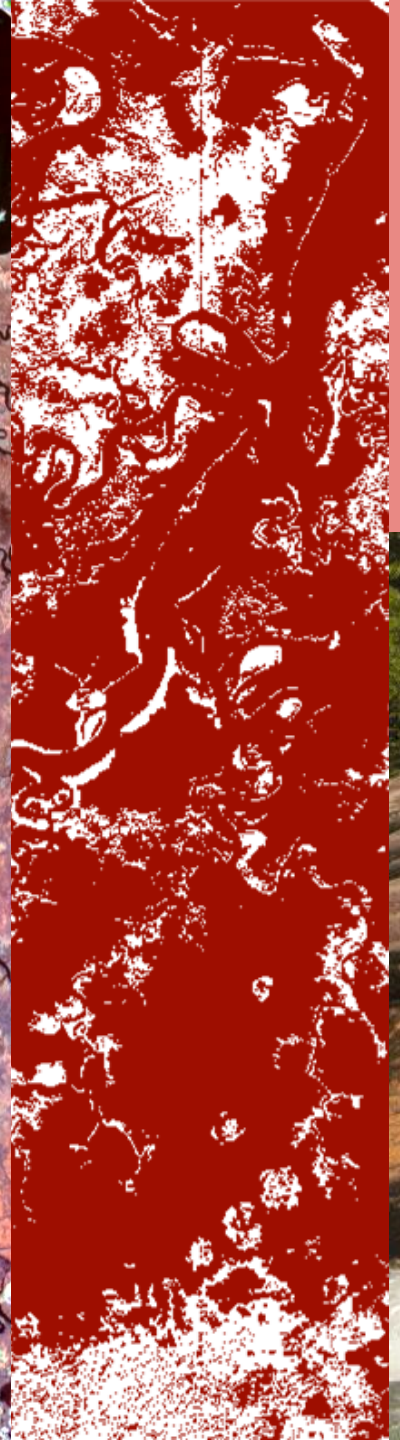
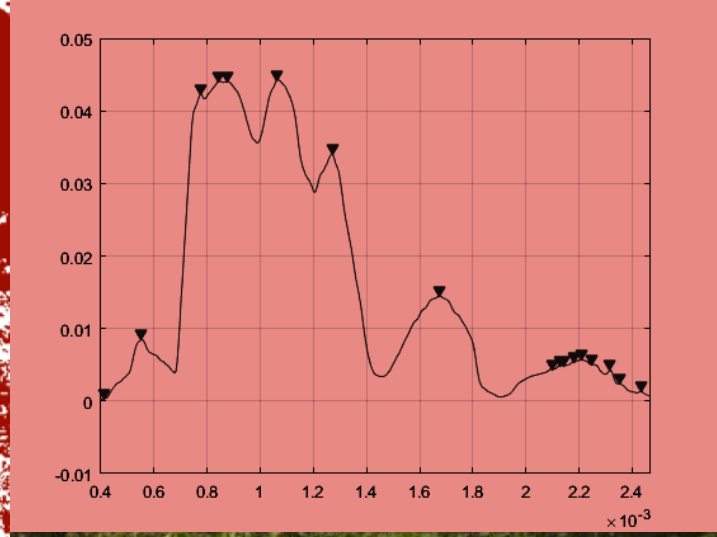
0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4
×10^-3



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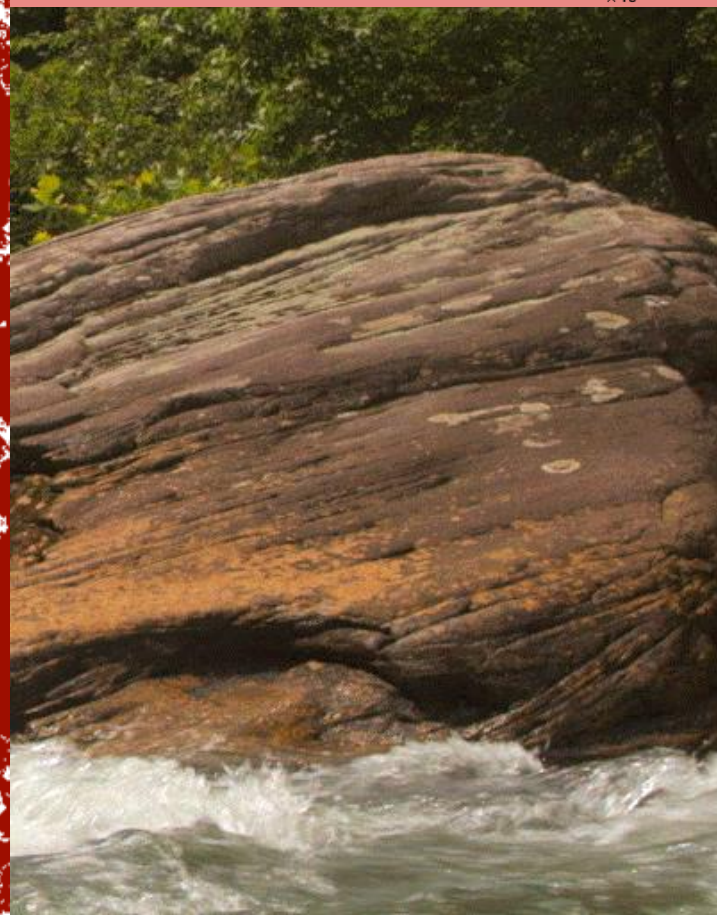

In next episode:

- Open source deep learning framework for advanced spectrum-material data matching.
- More flexible spectral data type support.
- Low cost VIR range hyperspectral imaging hardware and UAV integration.

Thanks for your attention.