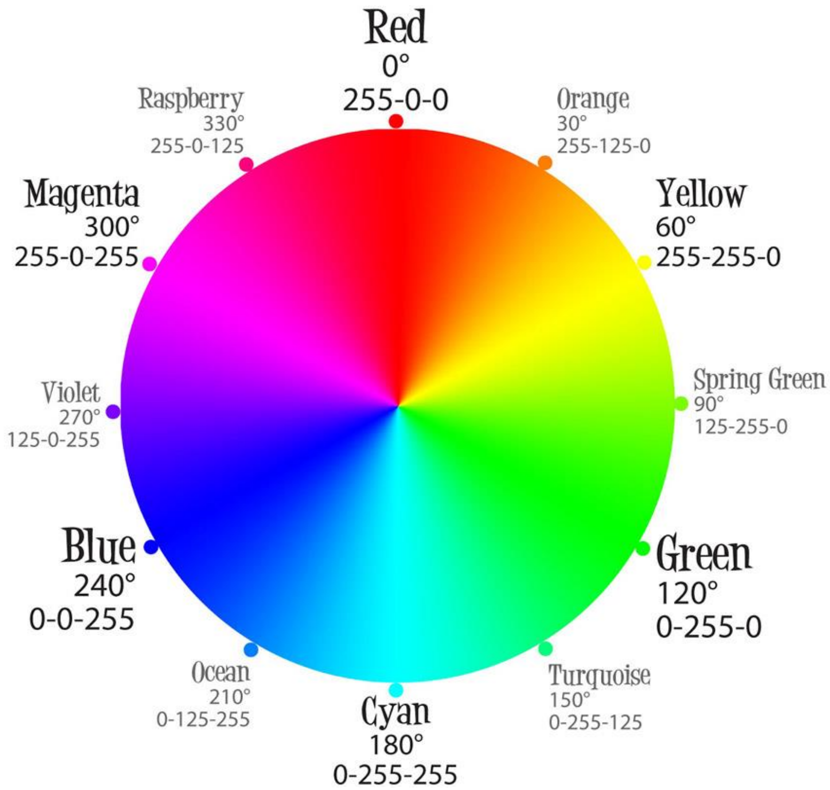
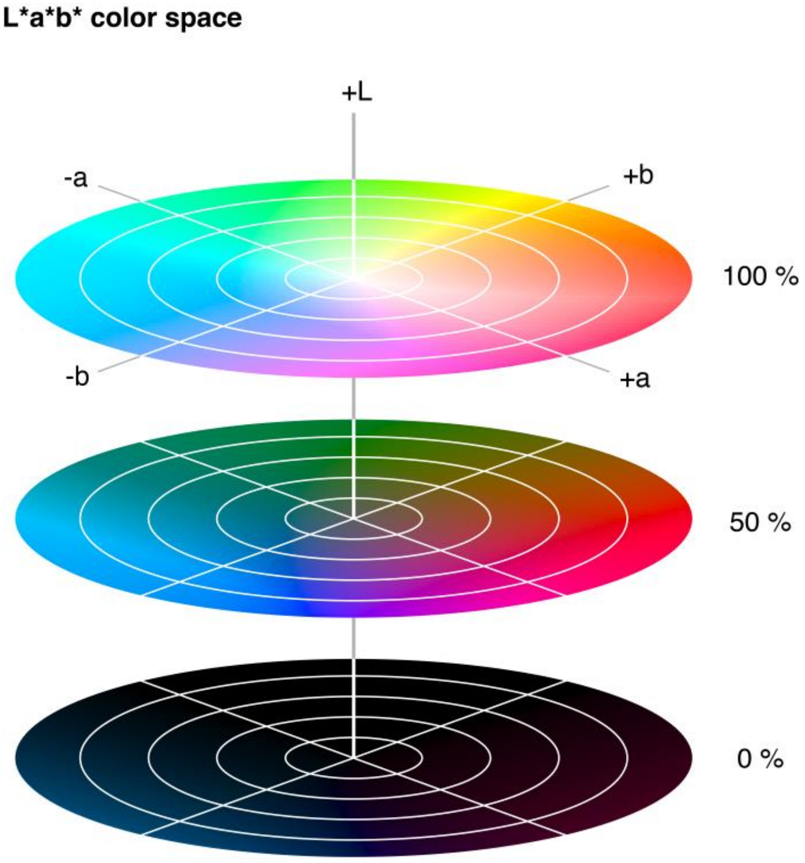
Cryo-Images Project

▪ Lab Color Space

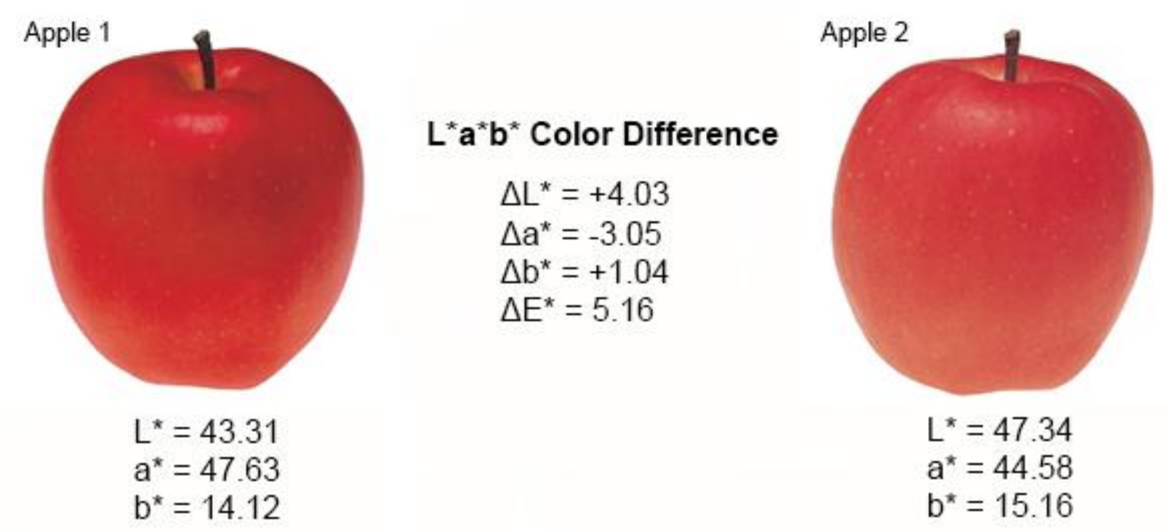
- L*a*b* color space was modeled after a color-opponent theory stating that two colors cannot be red and green at the same time or yellow and blue at the same time.
- As shown below, L* indicates lightness, a* is the red/green coordinate, and b* is the yellow/blue coordinate. Deltas for L* (ΔL*), a* (Δa*) and b* (Δb*) may be positive (+) or negative (-). The total difference, Delta E (ΔE*), however, is always positive.





RGB and Lab Color Space

- L*a*b* color space was modeled after a color-opponent theory stating that two colors cannot be red and green at the same time or yellow and blue at the same time.
- To determine the total color difference between all three coordinates, the following formula is used: $\Delta E^* = [\Delta L^*2 + \Delta a^*2 + \Delta b^*2]1/2$.

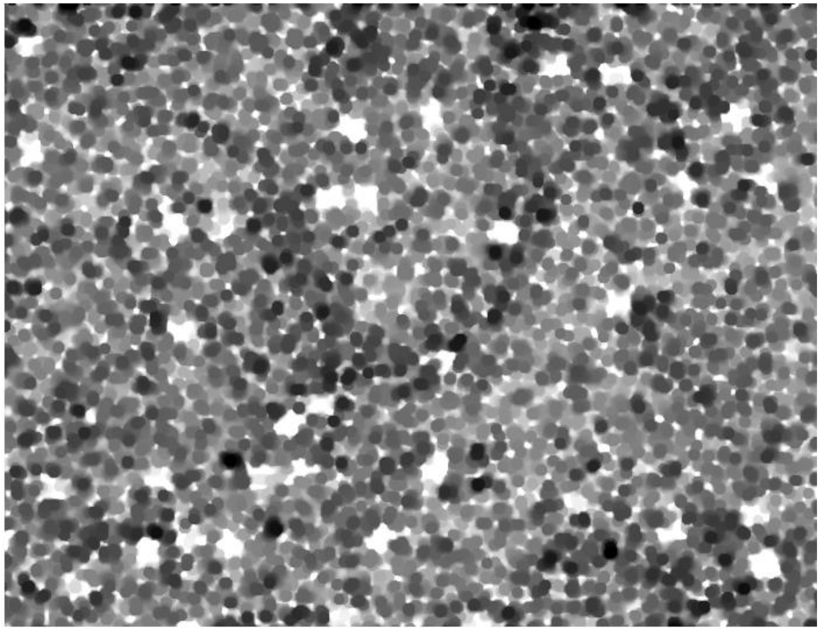


- Looking at the L*a*b* values for each apple in Figure 1, we can objectively determine that the apples don't match in color. These values tell us that Apple 2 (sample) is lighter, less red, and more yellow in color than Apple 1 (standard). If we put the values of $\Delta L^*=+4.03$, $\Delta a^*=-3.05$, and $\Delta b^*=+1.04$ into the color difference equation, it can be determined that the total color difference between the two apples is 5.16.

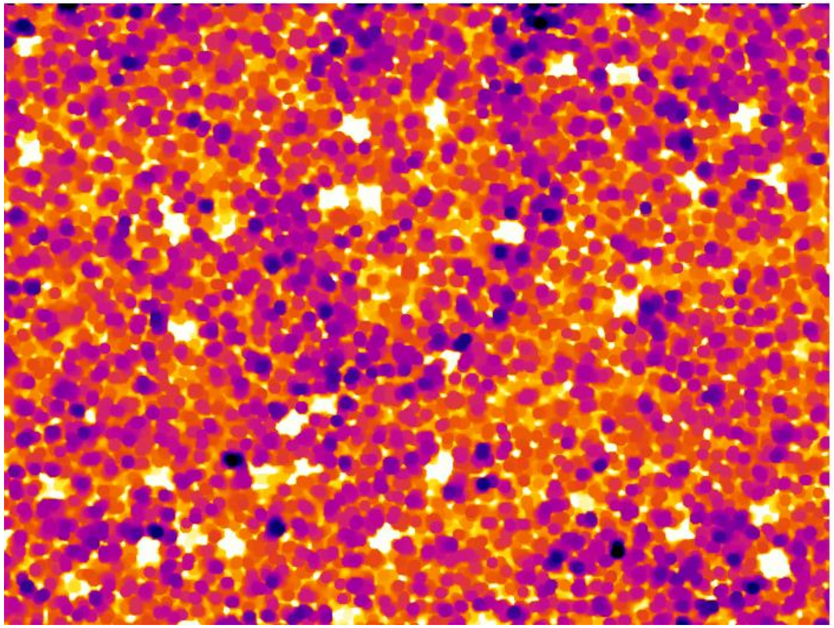
▪ Colored (RGB) CryoEM Image

- To convert the CryoEM from grayscale to RGB color space then to the Lab space we used the following steps.
  - **Step1**: Load an Coloring Map
  - **Step2**: Build a LOOK UP Table based on the MIN and the MAX color value in the grayscale image to scale the gray image to the color map.
  - **Step3**: Generate the RGB image from the scaled map

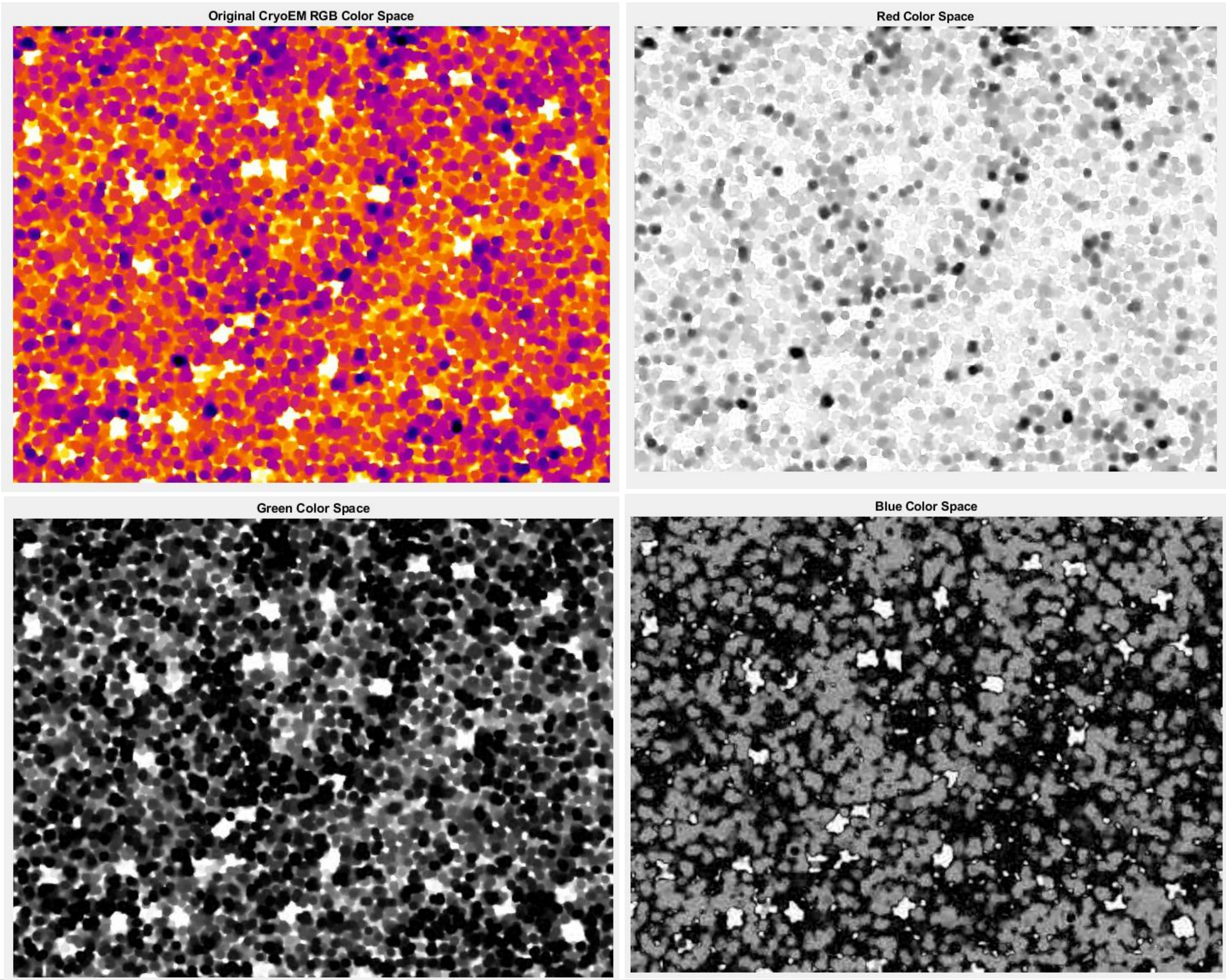
Original Grayscale CryoEM Image



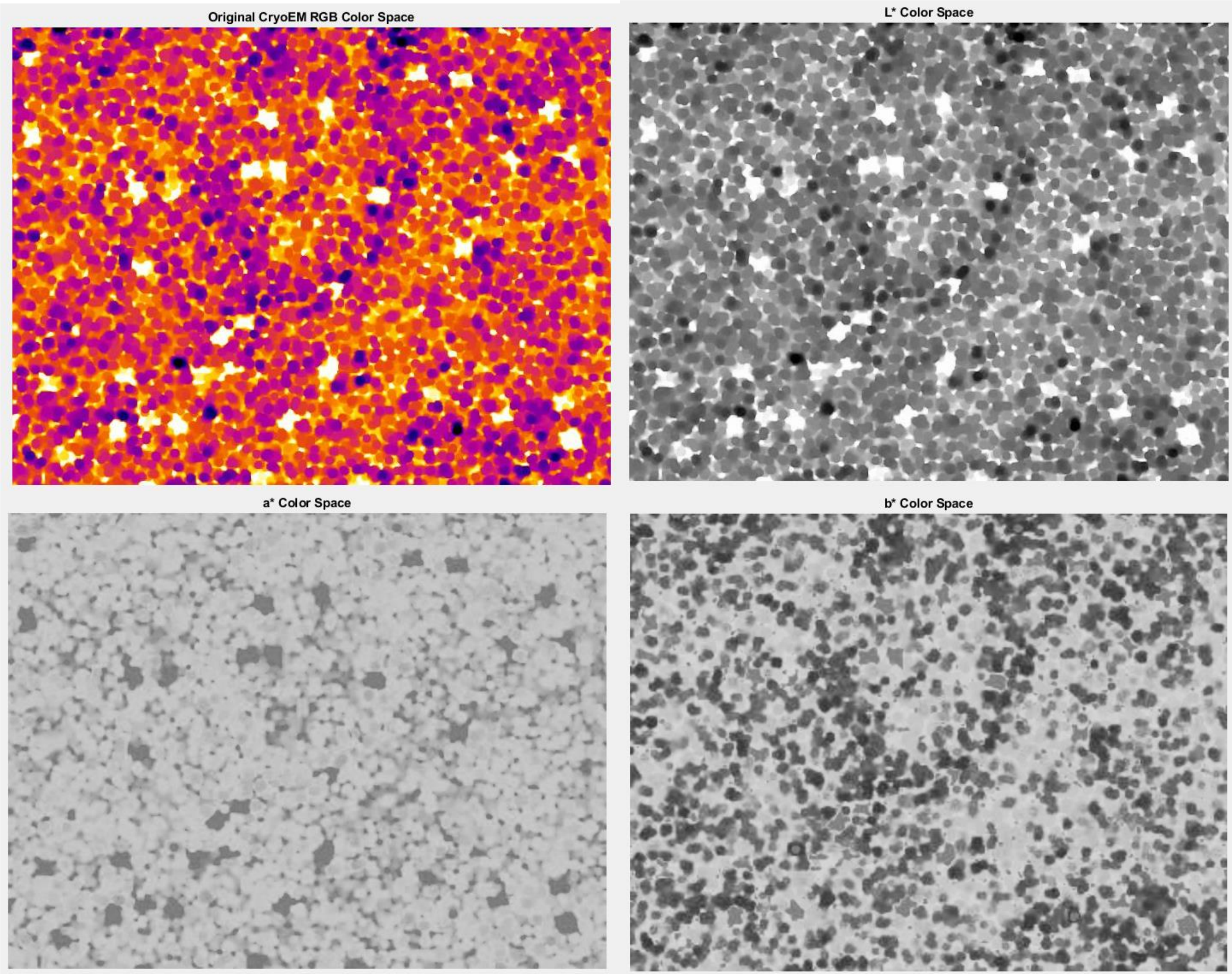
Colored CryoEM Image



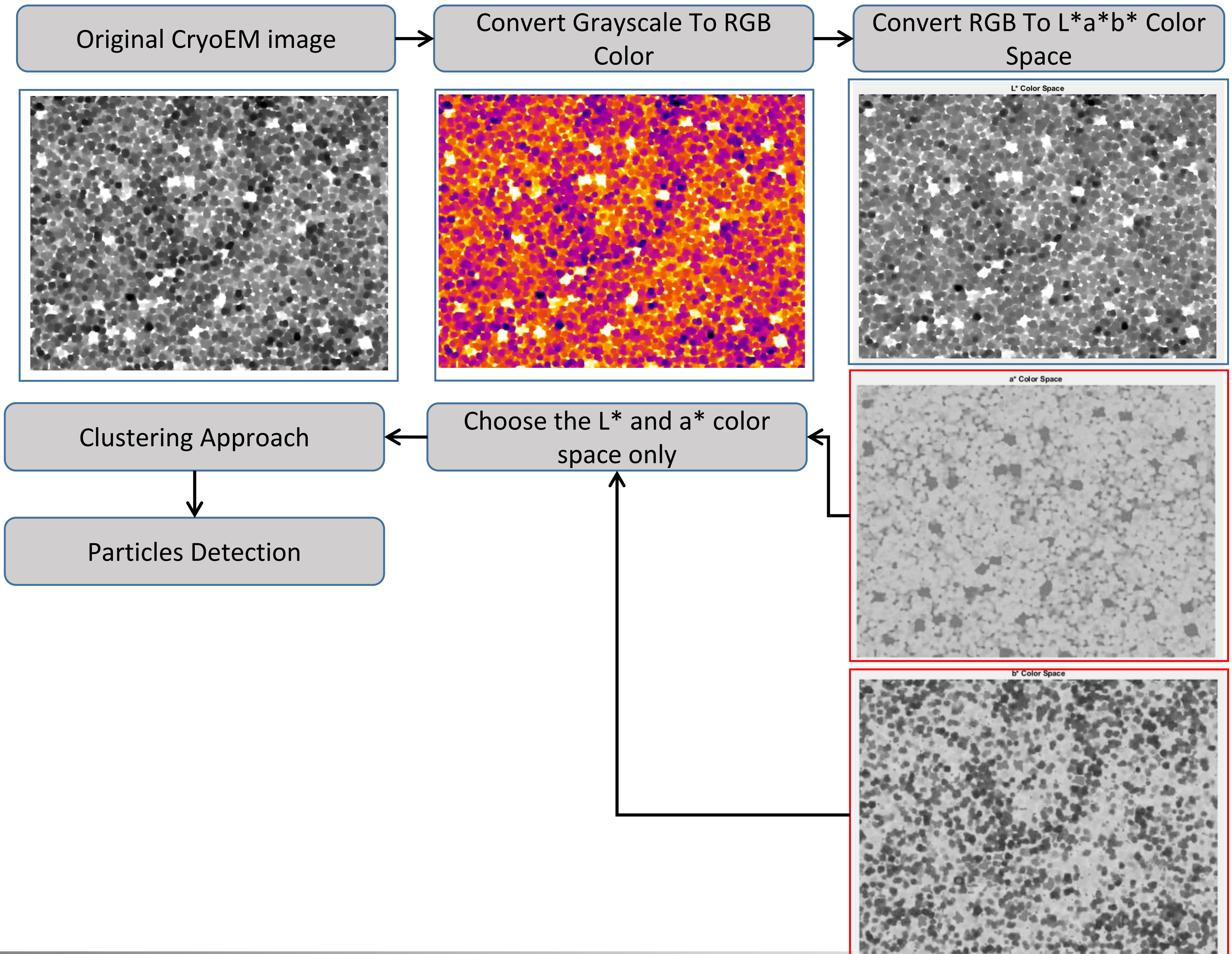
▪ CryoEM Image in RGB Color Space



▪ CryoEM Image in L*a*b* Color Space



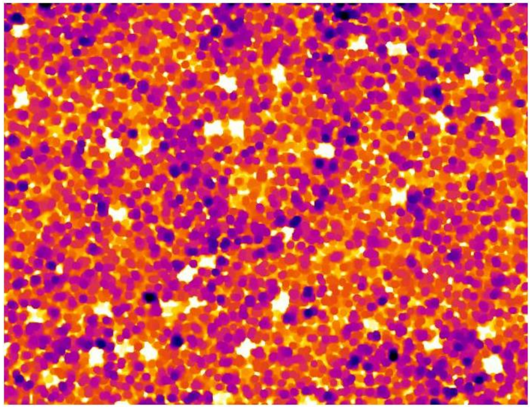
▪ CryoEM Image Based L*a*b* Clsutering Approach



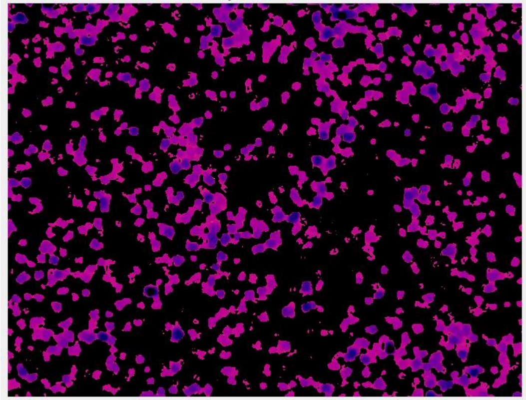
Self-Organizing Map (SOM)

- The Self-Organizing Map (SOM) is one of the most popular neural network models. It belongs to the category of competitive learning networks.
- SOM is based on unsupervised learning, which means that no human intervention is needed during the learning and that little needs to be known about the characteristics of the input data.
- Basically, the SOM is used for clustering data without knowing the class memberships of the input data.
- The SOM algorithm provides a topology preserving mapping from the high dimensional space to map units.
  - The property of topology preserving means that the mapping preserves the relative distance between the points.
  - Points that are near each other in the input space are mapped to nearby map units in the SOM.
  - The SOM can thus serve as a cluster analyzing tool of high-dimensional data.
  - SOM has the capability to generalize that means the network can recognize or characterize inputs it has never encountered before.
  - A new input is assimilated with the map unit it is mapped to.
- The SOM clustering consist many stages such as:
  - Initialization : Choose random values for the initial weight vectors W_j .
  - Sampling : Draw a sample training input vector x from the input space.
  - Matching : Find the winning neuron $I(x)$ with weight vector closest to input vector.
  - Updating : Apply the weight update equation $\Delta W_{ji} = \eta(t)T_{j,I(x)}(t)(x_i - w_{ji})$
  - Continuation : keep returning to step 2 until the feature map stops changing.

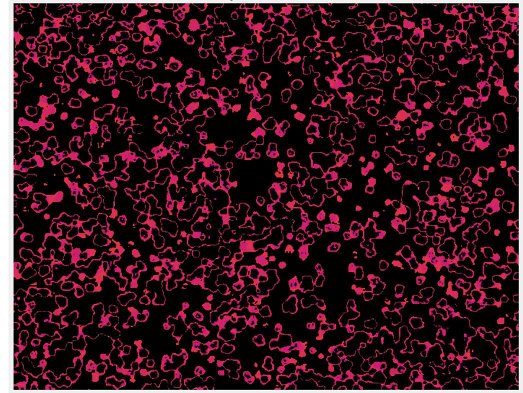
▪ CryoEM Image Clustering using SOM



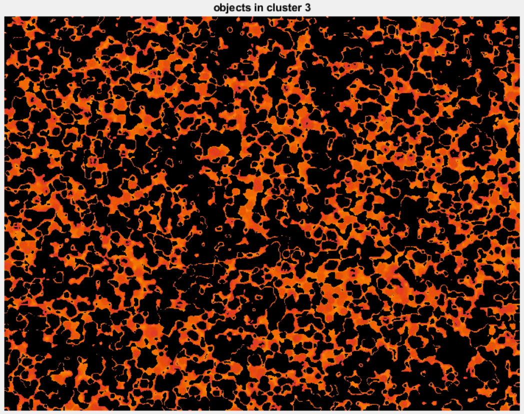
objects in cluster 1



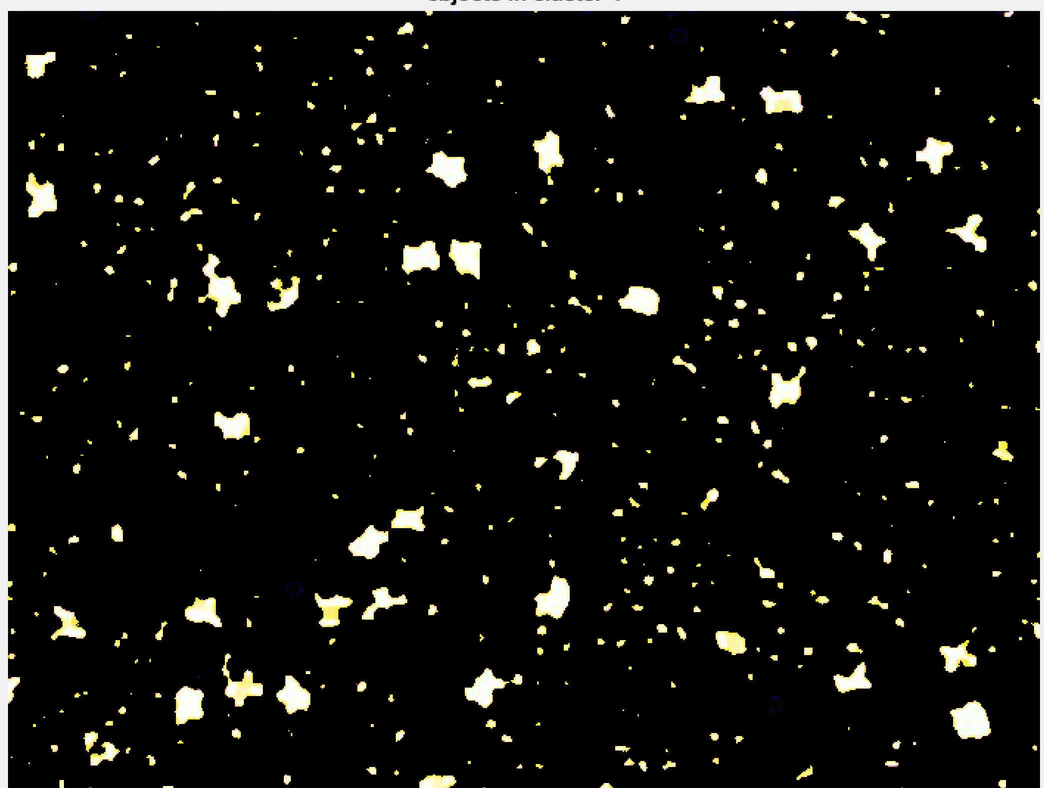
objects in cluster 2



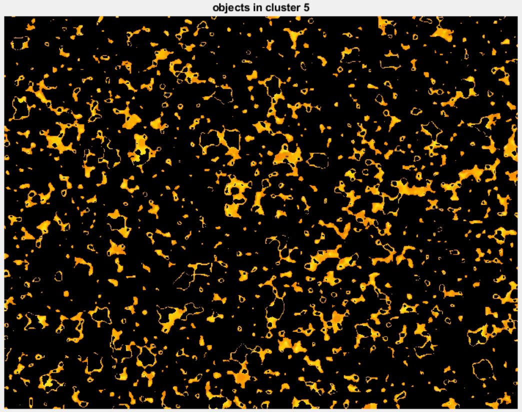
objects in cluster 3



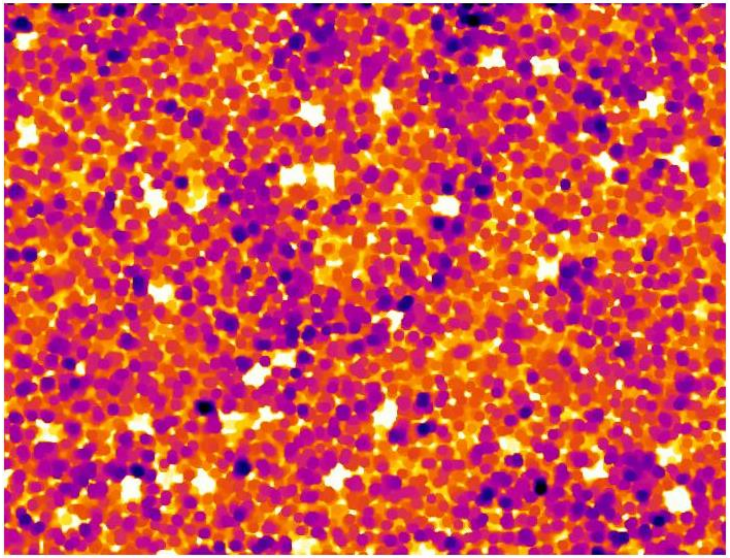
objects in cluster 4

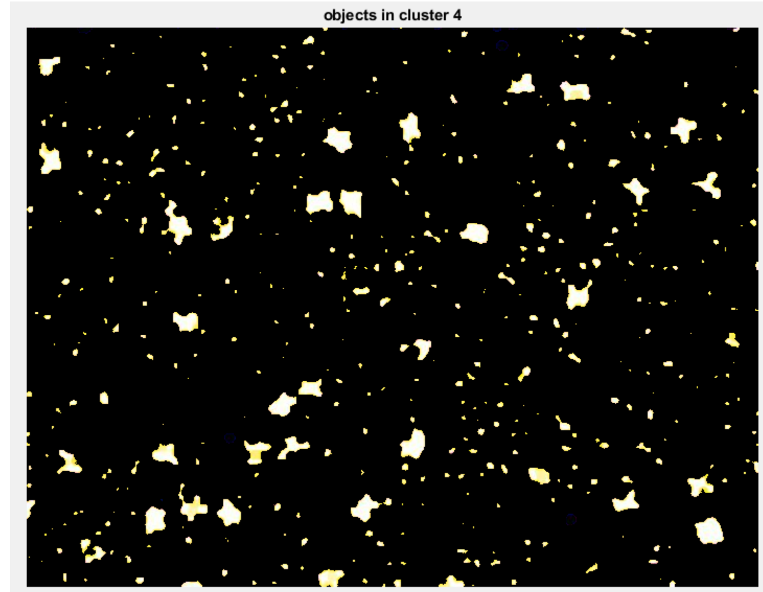


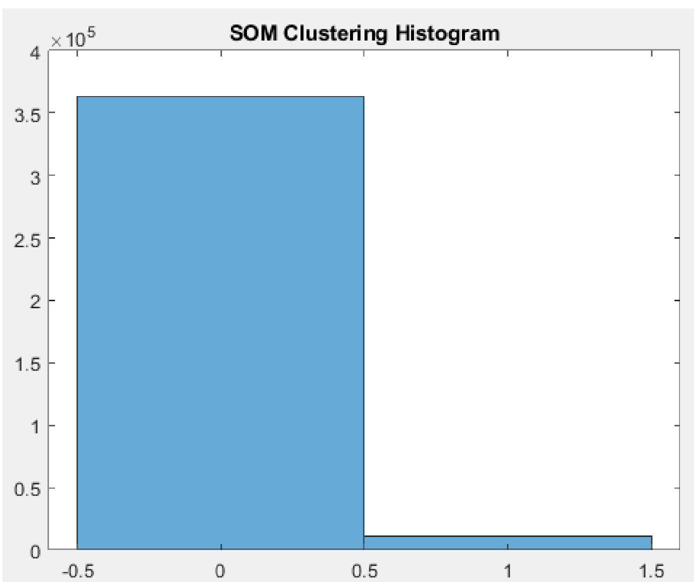
objects in cluster 5



CryoEM Image Clustering using SOM

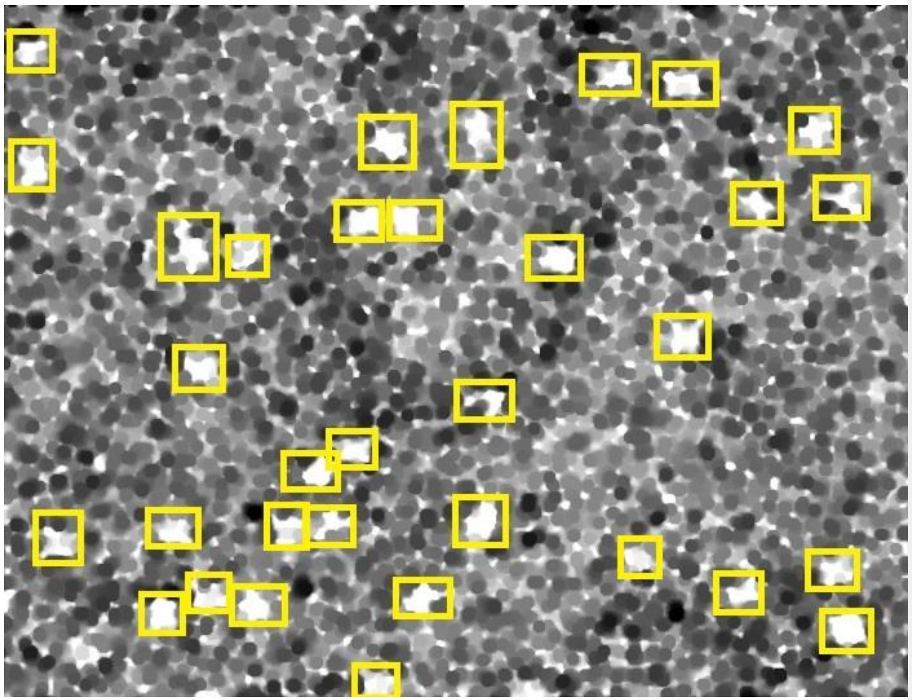




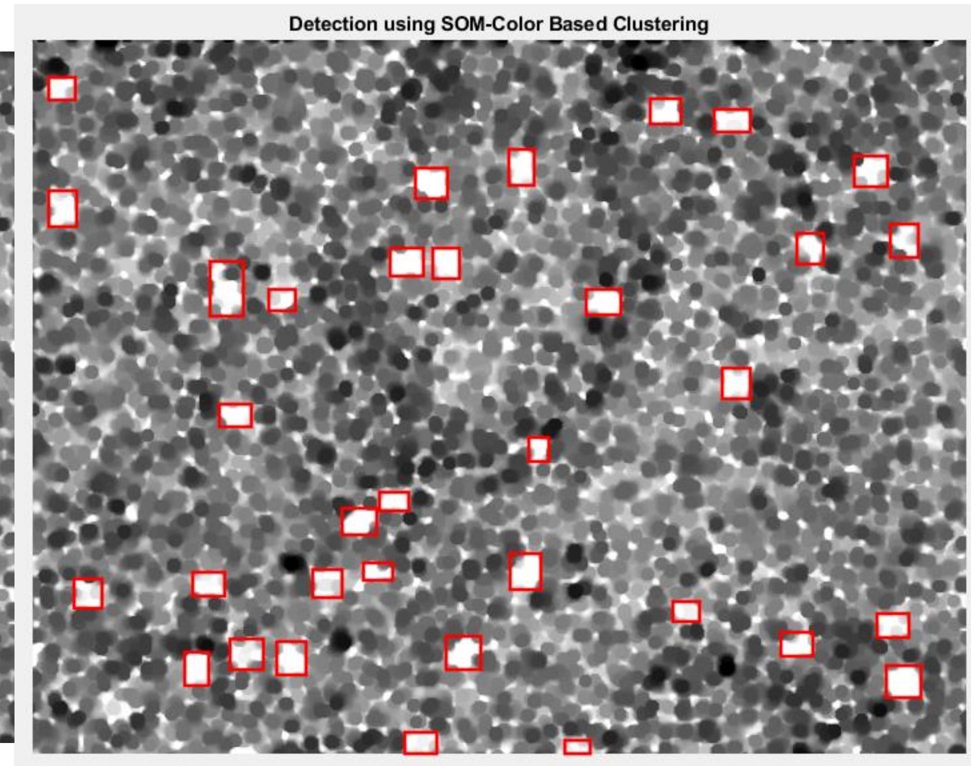


▪ CryoEM Image Clustering using SOM

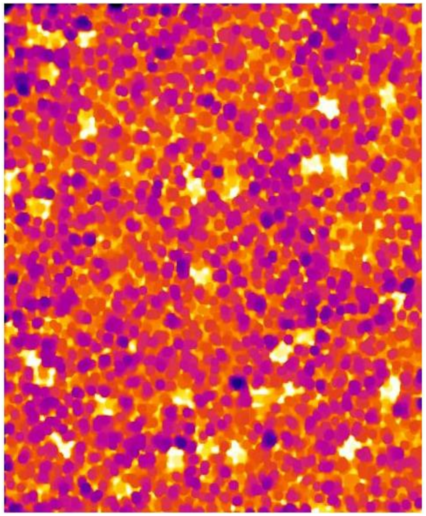
33 Particles as a GT



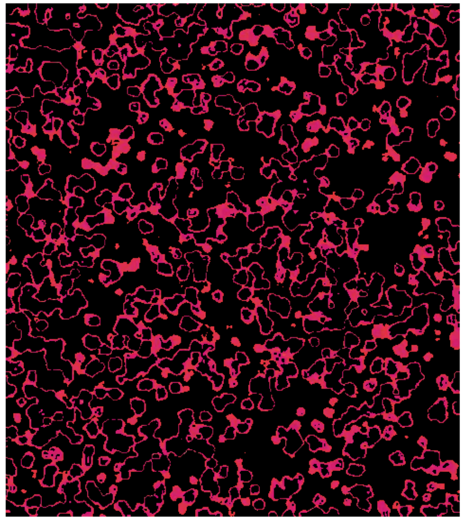
34 Particles Detected



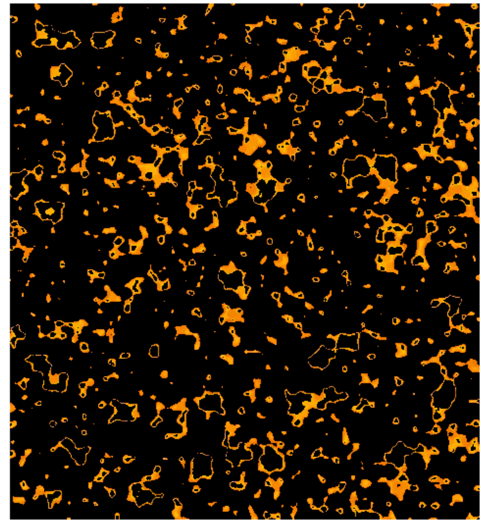
▪ CryoEM Image Clustering using SOM



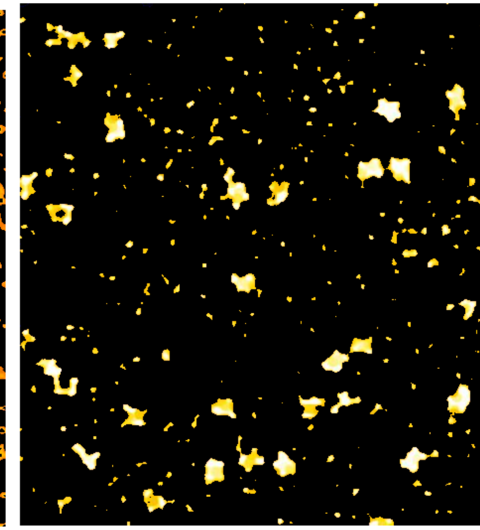
objects in cluster 1



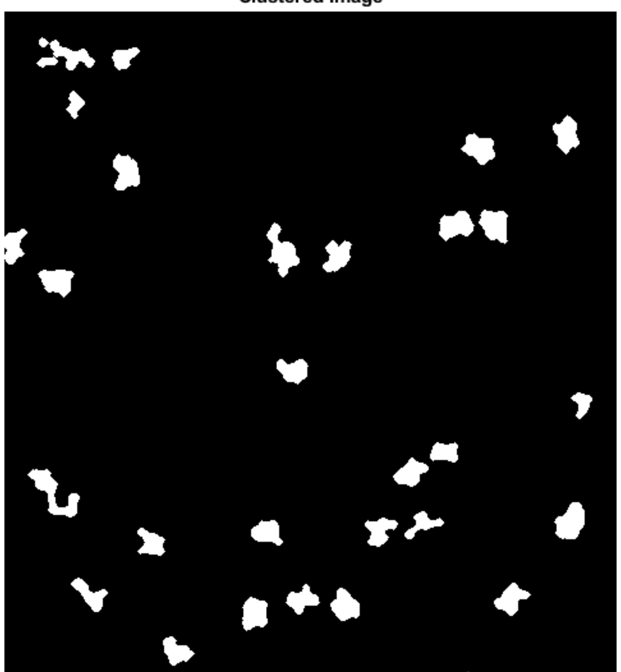
objects in cluster 2



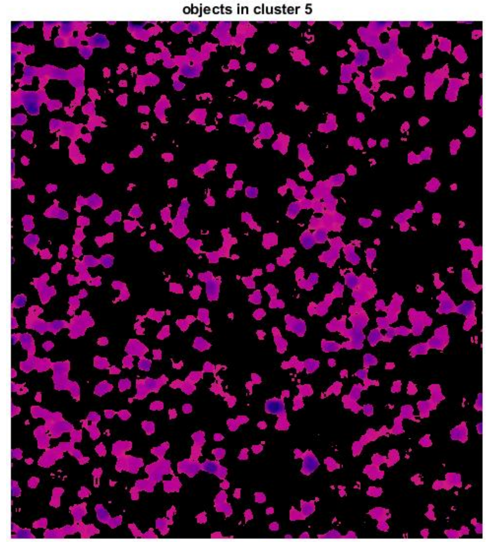
objects in cluster 3



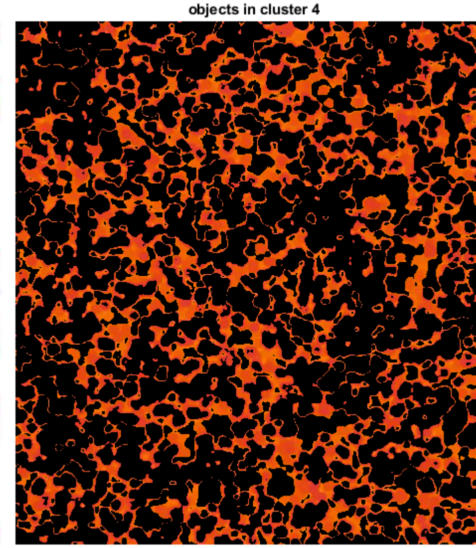
Clustered Image



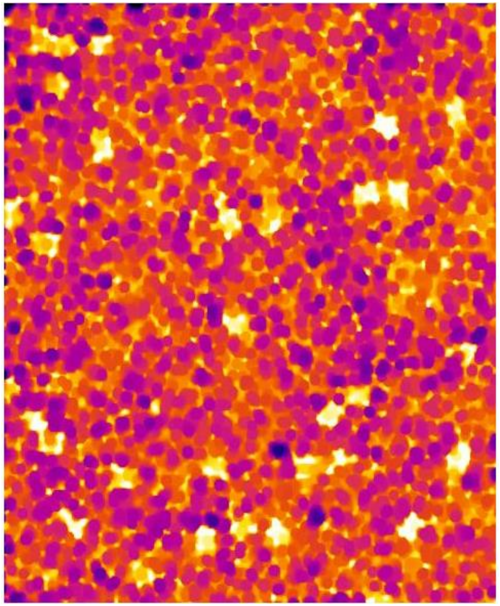
objects in cluster 5

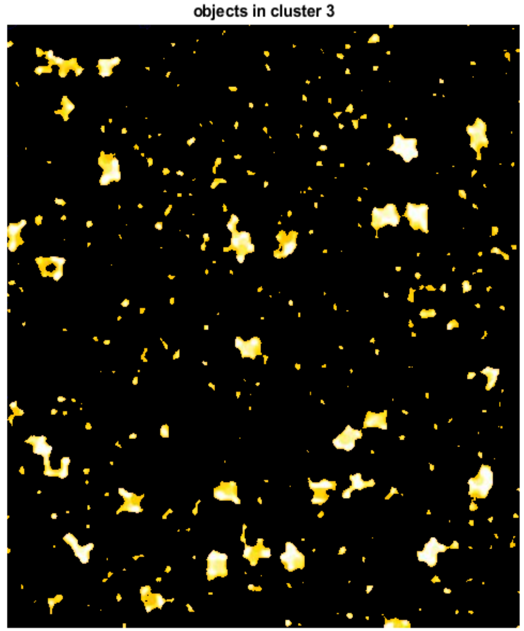


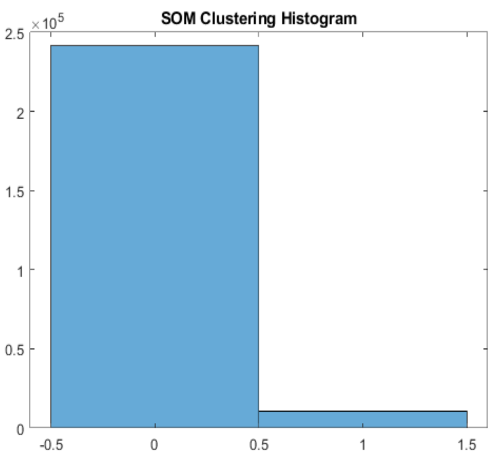
objects in cluster 4

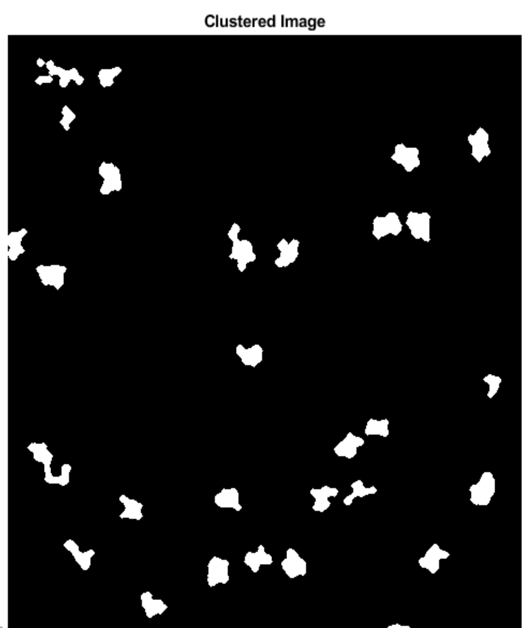


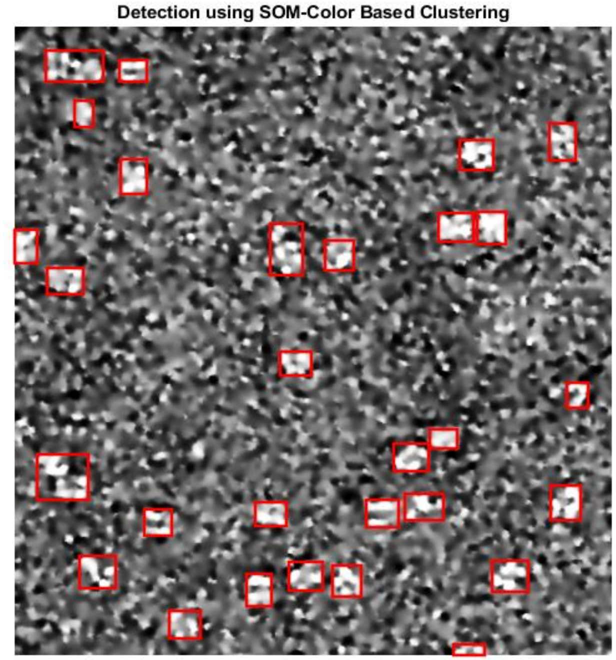
▪ CryoEM Image Clustering using SOM

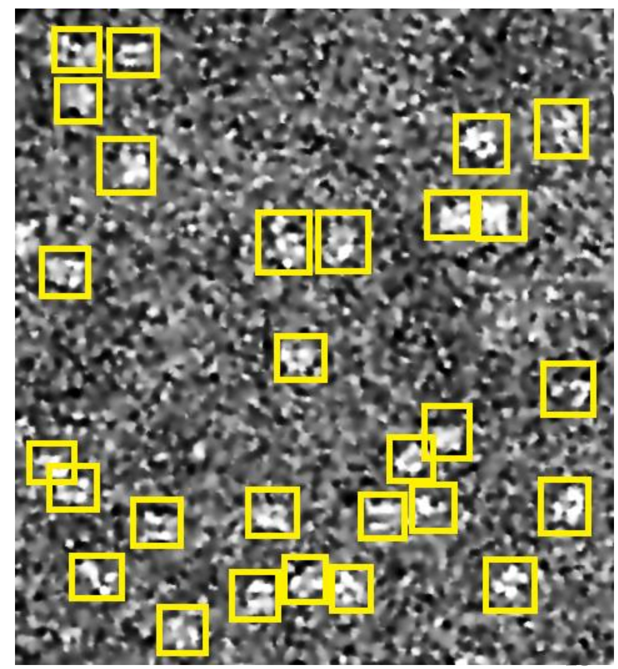












▪ CryoEM Image Clustering using SOM