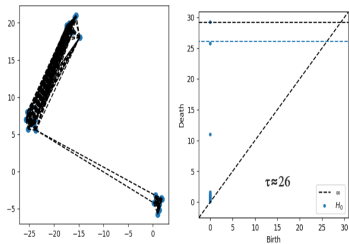
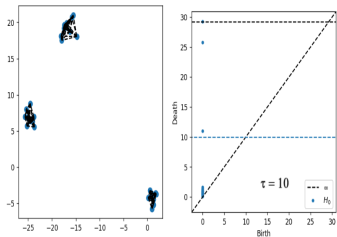
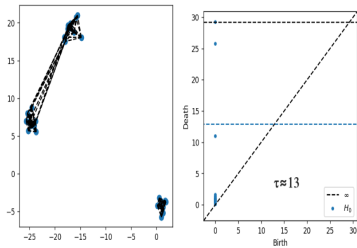
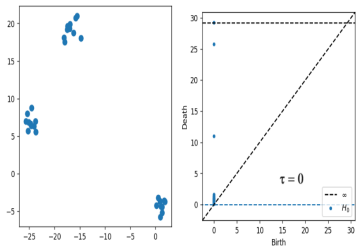


Topological Data Analysis (TDA) Pipeline

- **Data Representation:** Represent the dataset as a point cloud in a high-dimensional space with a distance metric.
- **Simplicial Complex Construction:**
 - Connect points to form simplices.
 - Aggregate simplices into a complex.
- **Filtration:** Introduce a filtration parameter " t " and vary it.
- **Persistence:**
 - Track topological changes during filtration.
 - Capture birth and death of topological features.

Topological Data Analysis (TDA) Pipeline (cont.)

- **Topological Summarization:** Summarize features using barcodes or persistence diagrams.
- **Interpretation and Visualization:**
 - Interpret results in the context of the original data.
 - Visualize persistent homology using landscapes, heatmaps, etc.
- **Validation and Application:**
 - Validate results against domain knowledge.
 - Apply findings for insights into dataset structure.
- **Integration:**
 - Cluster data based on topological features.
 - Incorporate topological loss functions into machine learning.



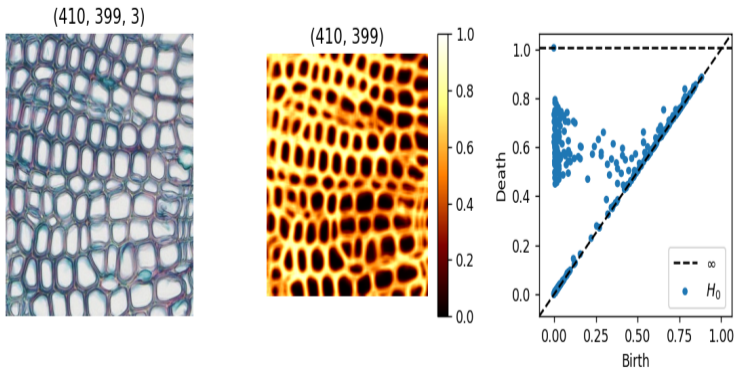


Figure: Homology of a wood cell wall. Filtered by pixel intensity.

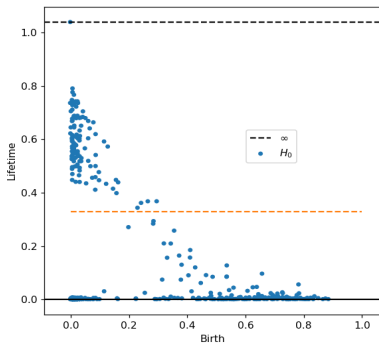
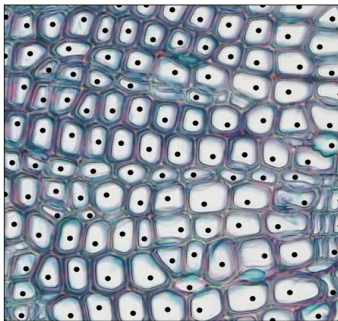


Figure: Filtered wood cell wall.

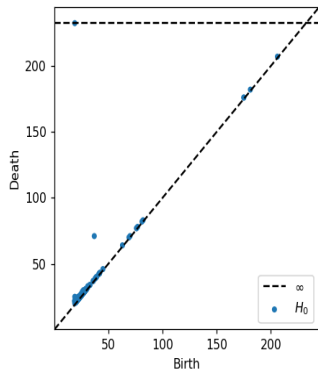
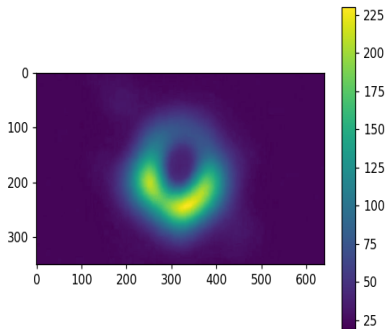


Figure: An image of the black hole at the center of the galaxy M87.

```
plt.figure()  
plt.imshow(blackhole_grey < 60)
```

Figure 7

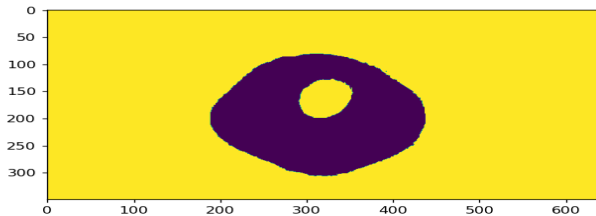


Figure: Proof that black holes do have holes

TDA for Wave Data Pipeline

- **Data Representation:** Represent wave data as point clouds in a high-dimensional space.
- **Simplicial Complex Construction:**
 - Need to know first what the data represents.
 - Construct a simplicial filtration that captures the structure of the data.
- **Lower Star Filtration:** Apply a lower star filtration method. Good for reconstruction of physical space.
- **Persistence:**
 - Track changes during the filtration.
 - Capture birth and death of topological features using persistent homology.

TDA for Wave Data Pipeline (cont.)

- **Topological Summarization:** Summarize persistent features using persistence landscapes.
- **Interpretation and Visualization:**
 - Interpret results in the context of wave data.
 - Visualize persistent homology using barcodes, persistence diagrams, etc.
- **Validation and Application:**
 - In some cases, "Persistent" topological features should correspond to wave features of high amplitude.
 - The physical reality (obstructions) of the data should be reflected in the topological features of our data.
- **Integration:**
 - Incorporate in ML pipeline for obstruction / feature detection in noisy data.
 - Object detection in sonar, radar, etc.

Conclusion

Thank you for your time!