Ligo Primary Analysis

- Tested on Intel based Linux.
- Notebook issue with it being too large to save with renders. Hence PDF screenshot will be provided. Request to run the notebook for visuals in the jupyter enviornment. The file is in the same folder called: ligo_primary_analysis_notebook.pdf and contains the rendered version of this file.
- Notebook may take a while to render. This is partly due to graphic processing, and also due to the fact this code was not performance optimized. Please be patient (we've seen 15-20 minutes) for the full render.
- Installation instructions to notebook on the README
- python -m pip install -r requirements_primary.txt for installing the relevant libs

0. Imports

In [1]:
```
!python -m pip install -q -r requirements_primary.txt
import logging
import json
import inspect
import readligo as rl
import matplotlib.mlab as mlab
from scipy.interpolate import interp1d
import matplotlib.pyplot as plt
import os
import numpy as np
from gwosc.locate import get_urls
import requests
import os
from gwosc.locate import get_urls
from scipy import signal
from gwpy.timeseries import TimeSeries

logger = logging.getLogger()
logger.setLevel(logging.INFO)

from rk_visualizer import *
app = RKModelApplication(master=root)
visualizer = RKGraphVisualizer(app)
```

```
WARNING: Running pip as the 'root' user can result in broken permissions and conflicting behaviour with the system package manager. It is recommended to use a virtual environment instead: https://pip.pypa.io/warnings/venv
```

In [2]:
```
# Uncomment this section if using on a server w/o a display!

#import os
#os.system("Xvfb :1 -screen 0 720x720x16 &")
#os.environ['DISPLAY'] = ":1.0"
```

1. Read LIGO Strain Data & Load for Analysis

In [10]:
```
detector = 'H1'
event_data  = {'GW170729': {'t': 1185389807.3},
               'GW170817': {'t': 1187008882.4},
               'GW190521': {'t': 1242442967.4},
               'GW190814': {'t': 1249852257.0}}

for name, event in event_data.items():
    url = get_urls(detector, event['t'], event['t'])[-1]
    fn = os.path.basename(url)
    n = url.split("/")[-3]
    event_data[n]["path"] = fn
    if not os.path.exists(fn):
        print('Downloading: ' , url)
        with open(fn,'wb') as strainfile:
            straindata = requests.get(url)
            strainfile.write(straindata.content)
    else:
        print("already downloaded {}. skipping".format(fn))

# using the tool
visualizer.load_data()
print(inspect.getsource(visualizer.load_data))
```

```
already downloaded H-H1_GWOSC_4KHZ_R1-1185387760-4096.hdf5. skipping
already downloaded H-H1_GWOSC_4KHZ_R1-1187006835-4096.hdf5. skipping
```

```
already downloaded H-H1_GWOSC_4KHZ_R1-1242440920-4096.hdf5. skipping
already downloaded H-H1_GWOSC_4KHZ_R1-1249850209-4096.hdf5. skipping
Trying to find event for 1185389807.3: https://www.gw-openscience.org/eventapi/json/GWTC-1-confident/GW170729/v1/H-H1_GWOSC
_4KHZ_R1-1185387760-4096.hdf5
GW170729 is already downloaded
Trying to find event for 1187008882.43: https://www.gw-openscience.org/eventapi/json/GWTC-1-confident/GW170817/v3/H-H1_GWOS
C_4KHZ_R1-1187006835-4096.hdf5
GW170817 is already downloaded
Trying to find event for 1242442967.4: https://www.gw-openscience.org/eventapi/json/GWTC-2.1-confident/GW190521/v4/H-H1_GWO
SC_4KHZ_R1-1242440920-4096.hdf5
GW190521 is already downloaded
Trying to find event for 1249852257.0: https://www.gw-openscience.org/eventapi/json/GWTC-2.1-confident/GW190814/v3/H-H1_GWO
SC_4KHZ_R1-1249850209-4096.hdf5
GW190814 is already downloaded
```

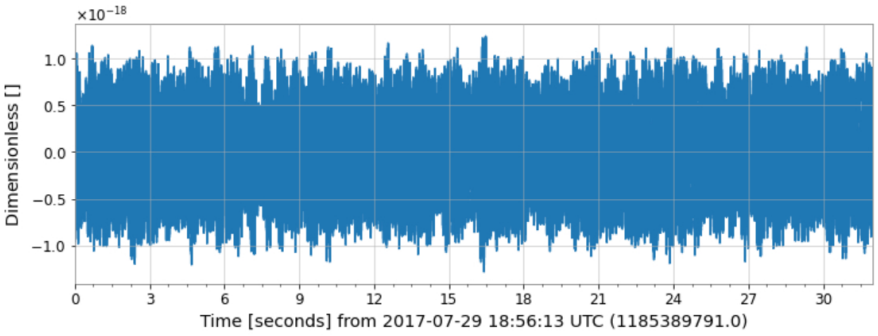
```
    def load_data(self):
        for event, data in event_names.items():
            t0 = data['ts']
            detector='H1'
            url = get_urls(detector, t0, t0)[-1]
            print("Trying to find event for {}: {}".format(t0, url))
            fn = os.path.basename(url)
            data['file'] = fn
            if not os.path.exists(fn):
                print('Downloading: ' , url)
                with open(fn,'wb') as strainfile:
                    straindata = requests.get(url)
                    strainfile.write(straindata.content)
            else:
                print("{} is already downloaded".format(event))
```

2. View Strain Data in Time Series

Note: We've seen some errors "OSError: Unable to open file (file signature not found)" crop up sometime. This is due to a corruption during the file download process. In the case that OSError happens, please remove the file and redo the download.

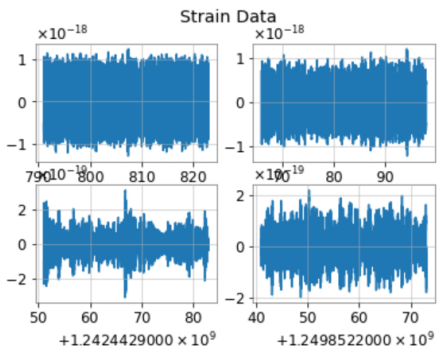
In [11]:

```
focus_event = 'GW170729'
strain = TimeSeries.read(event_data[focus_event]['path'],format='hdf5.losc')
center = int(event_data['GW170729']['t'])
strain = strain.crop(center-16, center+16)
fig1 = strain.plot()
```



In [12]:

```
visualizer.plot_strain()
print(inspect.getsource(visualizer.plot_strain))
```

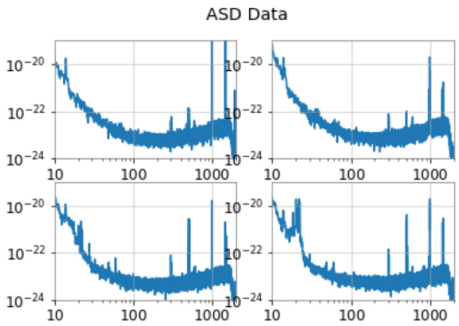



```
def plot_strain(self):
    figure = plt.gcf()
    figure.clf()
    figure.add_subplot(221)
    figure.add_subplot(222)
    figure.add_subplot(223)
    figure.add_subplot(224)
    axes = figure.get_axes()
    count=0
    figure.suptitle("Strain Data")
    for k,f in event_names.items():
        row = math.floor(count/2)
        col = count%2
        fn = f['file']
        if fn == "":
            return
```

```
        strain = self.get_strain(fn, f['ts'])
        axes[count].plot(strain)
        count+=1
    plt.show()
```

3. Plot ASD of Whitened & Band-Passed Strain

In [13]:
```
visualizer.plot_asd()
print(inspect.getsource(visualizer.plot_asd))
```

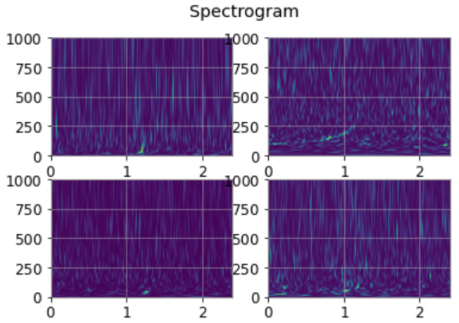



```
def plot_asd(self):
    figure = plt.gcf()
    figure.clf()
    figure.add_subplot(221)
    figure.add_subplot(222)
    figure.add_subplot(223)
    figure.add_subplot(224)
    axes = figure.get_axes()
    count=0
    figure.suptitle("ASD Data")
    for k,f in event_names.items():
        ax = axes[count]

        fn = f['file']
        if fn == "":
            return

        strain = self.get_strain(fn, f['ts'])
        f2 = strain.asd(fftlength=8)
        ax.plot(f2)
        ax.set_xlim(10,2000)
        ax.set_ylim(1e-24, 1e-19)
        ax.set_yscale('log')
        ax.set_xscale('log')
        count+=1
    plt.show()
```

4. Plot Multi-event Spectograms

In [14]:
```
visualizer.plot_spectrograms()
print(inspect.getsource(visualizer.plot_spectrograms))
```

```
/opt/conda/lib/python3.8/site-packages/gwpy/plot/axes.py:308: MatplotlibDeprecationWarning: shading='flat' when X and Y have the same dimensions as C is deprecated since 3.3.  Either specify the corners of the quadrilaterals with X and Y, or pass shading='auto', 'nearest' or 'gouraud', or set rcParams['pcolor.shading'].  This will become an error two minor releases later.
  return super().pcolormesh(*args, **kwargs)
```




```
def plot_spectrograms(self):
    figure = plt.gcf()
    figure.clf()
    figure.add_subplot(221)
    figure.add_subplot(222)
    figure.add_subplot(223)
    figure.add_subplot(224)
    axes = figure.get_axes()
    count=0
    figure.suptitle("Spectrogram")
    for k,f in event_names.items():
        ax = axes[count]
        fn = f['file']
        if fn == "":
```

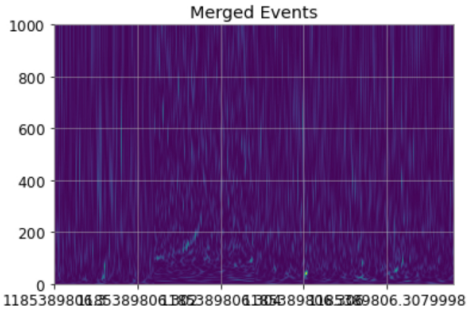
```
            return
        t0 = f['ts']
        strain = self.get_strain(fn, f['ts'])
        dt = 1  #-- Set width of q-transform plot, in seconds
        hq = strain.q_transform(outseg=(t0-dt, t0+dt))
        ax.pcolormesh(np.linspace(0,2.4,hq.shape[0]), np.linspace(0,1000,hq.shape[1]), hq.T)
        count+=1
    plt.show()
```

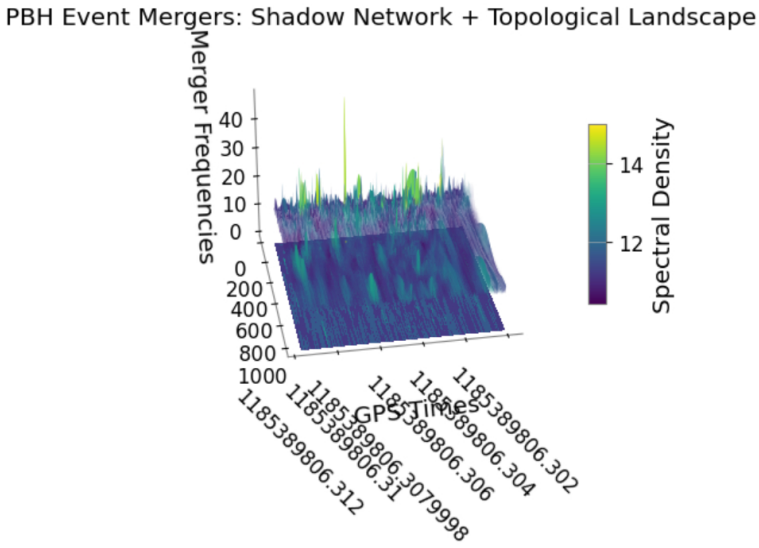
5. Merge Events in Frequency & Time Space and Unfiltered Topological Eventscape in 3D

In [15]:

```
visualizer.plot_eventscape()
print(inspect.getsource(visualizer.plot_eventscape))
```

```
/workspace/rk_gw_mma/rk_visualizer.py:147: UserWarning: FixedFormatter should only be used together with FixedLocator
  ax.set_xticklabels(xticksl)
/workspace/rk_gw_mma/rk_visualizer.py:174: UserWarning: FixedFormatter should only be used together with FixedLocator
  ax.set_xticklabels(xticksl)
/workspace/rk_gw_mma/rk_visualizer.py:178: UserWarning: Tight layout not applied. The left and right margins cannot be made large enough to accommodate all axes decorations.
  plt.tight_layout()
```






```
def plot_eventscape(self):
    count=0

    xticksl = []
    dt=3
    full_eventscape = []

    for k,f in event_names.items():
        fn = f['file']
        strain = self.get_strain(fn, f['ts'])
        dt = 1
        t0 = f['ts']
        hq = strain.q_transform(outseg=(t0-dt, t0+dt))
        xticksl.extend(hq.xindex.to_value())
        if len(full_eventscape) == 0:
            full_eventscape = np.array(hq)
        else:
            full_eventscape = np.concatenate([full_eventscape, np.array(hq)])

    xticks = np.linspace(0,2.4, 4000)
    yticks = np.linspace(0,1000, 2560)
    fig, ax = plt.subplots()
    ax.pcolormesh(xticks, yticks, full_eventscape.T)
    ax.set_xticklabels(xticksl)
    ax.set_title("Merged Events")

    fig = plt.figure(dpi=100)
    ax = fig.add_subplot(111, projection='3d')
    H = full_eventscape.T
    cmap='viridis'
    X, Y = np.meshgrid(xticks, yticks)
```

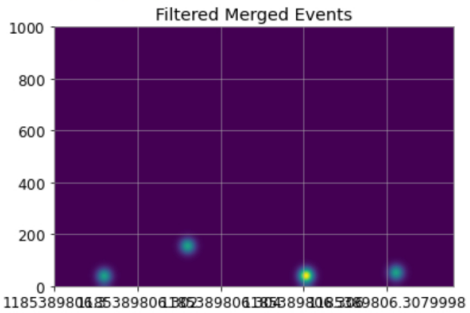
```
surf = ax.plot_surface(X, Y, H+10, cmap='viridis')
cset = ax.contourf(X, Y, H, zdir='z', offset=np.min(H)-2, cmap=cmap)

bar = fig.colorbar(surf, ax=ax, shrink=0.5, aspect=10)
bar.set_label("Spectral Density")
ax.set_xlabel('GPS Times')
ax.set_zlabel('Merger Frequencies')
ax.set_title('PBH Event Mergers: Shadow Network + Topological Landscape')
plt.grid(b=None)

# make the panes transparent
ax.xaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
ax.yaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
ax.zaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
# make the grid lines transparent
ax.xaxis._axinfo["grid"]['color'] =  (1,1,1,0)
ax.yaxis._axinfo["grid"]['color'] =  (1,1,1,0)
ax.zaxis._axinfo["grid"]['color'] =  (1,1,1,0)

ax.set_xticklabels(xticksl)

plt.xticks(rotation=-45)
ax.view_init(30, 80)
plt.tight_layout()
plt.show()
```

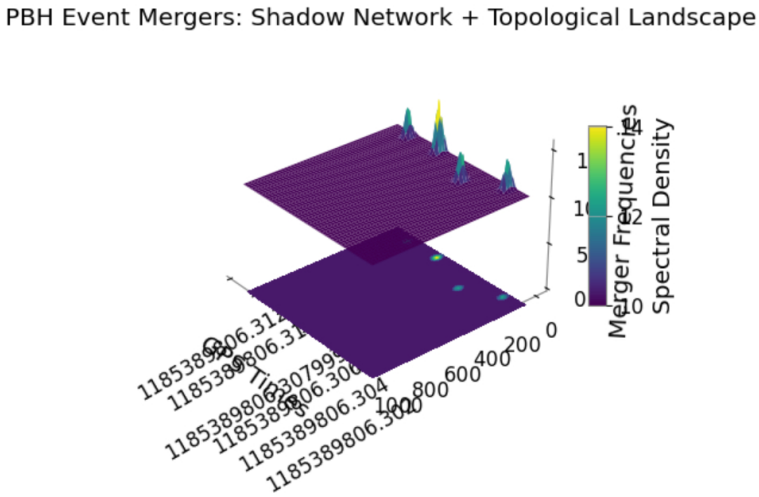
6 Filtered Topological Eventscape in 3D with Projected Events in 2D

In [16]:

```
visualizer.plot_filteredscape()
print(inspect.getsource(visualizer.plot_filteredscape))
```

```
/workspace/rk_gw_mma/rk_visualizer.py:210: UserWarning: FixedFormatter should only be used together with FixedLocator
  ax.set_xticklabels(xticksl)
/workspace/rk_gw_mma/rk_visualizer.py:237: UserWarning: FixedFormatter should only be used together with FixedLocator
  ax.set_xticklabels(xticksl)
/workspace/rk_gw_mma/rk_visualizer.py:242: UserWarning: Tight layout not applied. The left and right margins cannot be made large enough to accommodate all axes decorations.
  plt.tight_layout()
```





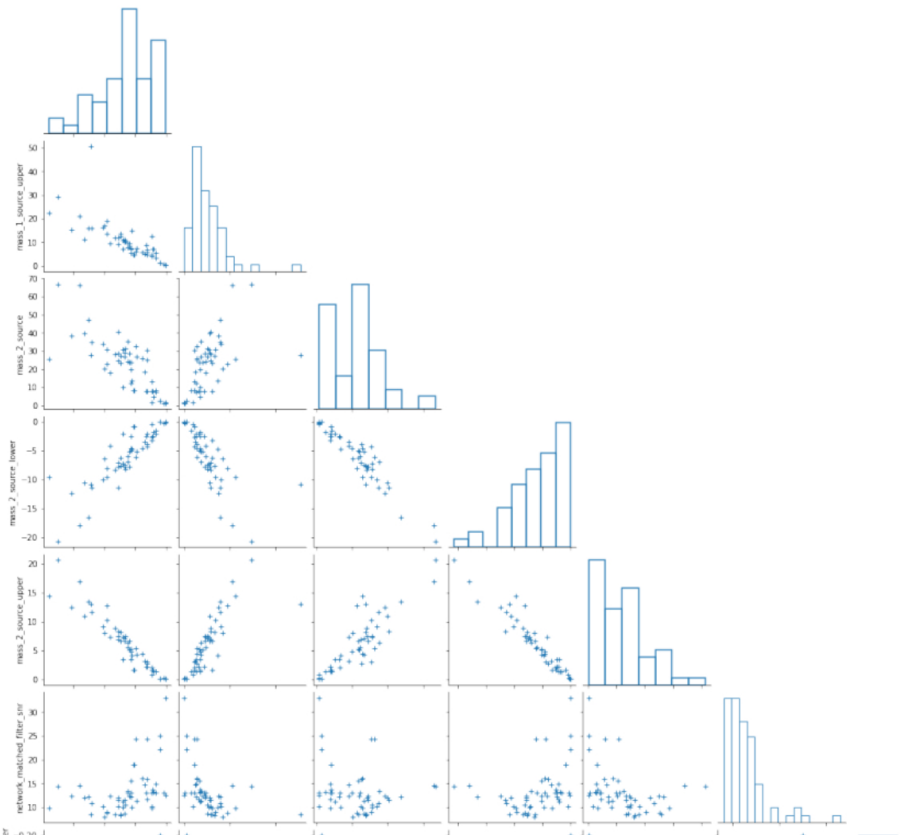

```
def plot_filteredscape(self):
    count=0

    xticksl = []
    dt=3
    full_eventscape = []

    for k,f in event_names.items():
        fn = f['file']
        strain = self.get_strain(fn, f['ts'])
        dt = 1
        t0 = f['ts']
        hq = strain.q_transform(outseg=(t0-dt, t0+dt))
        hq[hq < hq.max()] = 0
        xticksl.extend(hq.xindex.to_value())
        if len(full_eventscape) == 0:
```

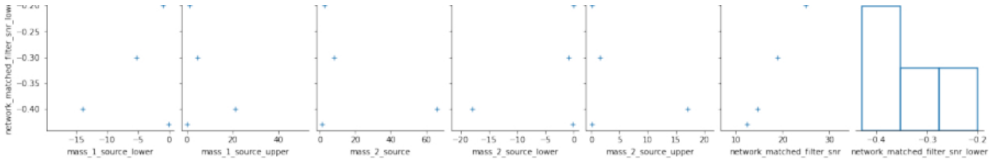
```
            full_eventscape = np.array(hq)
        else:
            full_eventscape = np.concatenate([full_eventscape, np.array(hq)])

    from scipy.ndimage import gaussian_filter, maximum_filter
    H = full_eventscape.T
    H = maximum_filter(H, size=50)
    H = gaussian_filter(H, sigma=50)

    xticks = np.linspace(0,2.4, 4000)
    yticks = np.linspace(0,1000, 2560)
    fig, ax = plt.subplots()
    ax.pcolormesh(xticks, yticks, H)
    ax.set_xticklabels(xticksl)
    ax.set_title("Filtered Merged Events")
    #plt.show()

    fig = plt.figure(dpi=100)
    ax = fig.add_subplot(111, projection='3d')

    cmap='viridis'
    X, Y = np.meshgrid(xticks, yticks)
    surf = ax.plot_surface(X, Y, H+10, cmap='viridis')
    cset = ax.contourf(X, Y, H, zdir='z', offset=np.min(H)-2, cmap=cmap)
    bar = fig.colorbar(surf, ax=ax, shrink=0.5, aspect=10)
    bar.set_label("Spectral Density")
    ax.set_xlabel('GPS Times')
    ax.set_zlabel('Merger Frequencies')
    ax.set_title('PBH Event Mergers: Shadow Network + Topological Landscape')
    plt.grid(b=None)

    # make the panes transparent
    ax.xaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
    ax.yaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
    ax.zaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
    # make the grid lines transparent
    ax.xaxis._axinfo["grid"]['color'] =  (1,1,1,0)
    ax.yaxis._axinfo["grid"]['color'] =  (1,1,1,0)
    ax.zaxis._axinfo["grid"]['color'] =  (1,1,1,0)

    ax.set_xticklabels(xticksl)

    #ax.set_zlim(1,20)
    plt.xticks(rotation=30)
    ax.view_init(30, 140)
    plt.tight_layout()
    plt.show()
```

7. Omniview of All Paramenter Estimate from Best Fit Model in Pair Plots

In [17]:

```
visualizer.plot_pair_plots()
print(inspect.getsource(visualizer.plot_pair_plots))
```

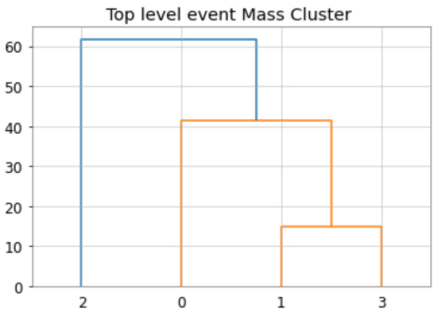


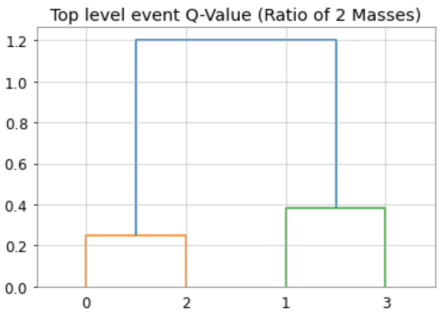


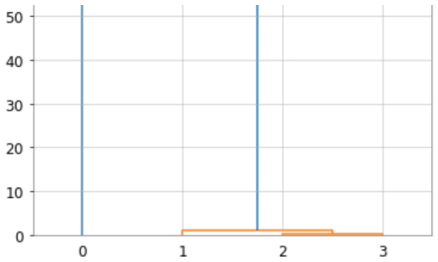

```
    def plot_pair_plots(self):
        '''
        plot secondary measures
        '''
        #import seaborn as sns
        #j
        #df = pd.read_csv("ligo_events.csv")
        #sns.pairplot(df.iloc[:,8:15], dropna=True, corner=True,     plot_kws=dict(marker="+", linewidth=1),  diag_kws=dict
(fill=False))
        fig, ax = plt.subplots(dpi=300)
        img = plt.imread("pairplot.png")
        ax.imshow(img)
        ax.axis('off')
        plt.show()
```

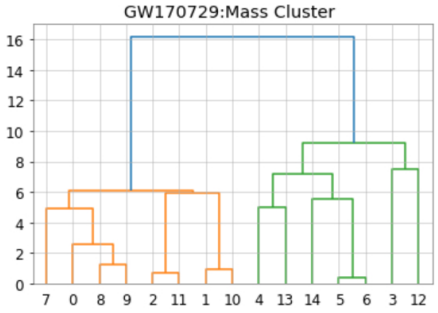
8. Plot Graph hierarchy for independent PE variable Clusters

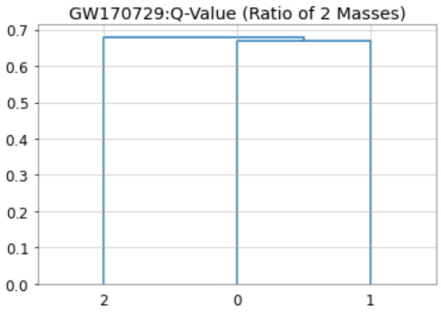
In [18]:
```
visualizer.plot_heirarchy()
print(inspect.getsource(visualizer.plot_heirarchy))
```

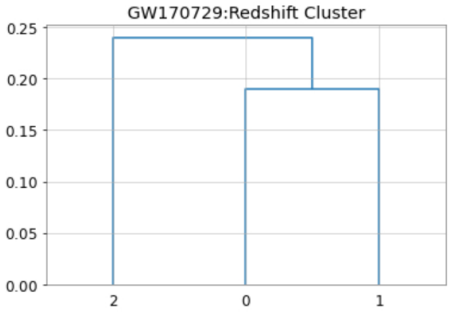


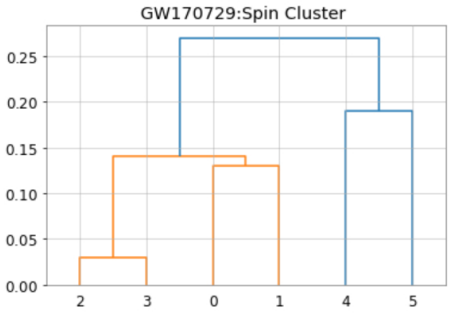













```
def plot_heirarchy(self):
    from scipy.cluster.hierarchy import dendrogram, linkage
    from matplotlib import pyplot as plt
    df = pd.read_csv("ligo_classifications2.csv")

    for i, g in df.groupby('Name of Cluster'):
        X = []
        for j, cluster in g.groupby('Event name '):
            X.append([cluster['Value of Each Node'].mean()])
        Z = linkage(X, 'single')
        fig,ax = plt.subplots()
        dn = dendrogram(Z)
        ax.set_title("Top level event {}".format(i))

    for i, g in df.groupby('Event name '):
        X = []
        for j, cluster in g.groupby('Name of Cluster'):
            X.append([cluster['Value of Each Node'].mean()])
        Z = linkage(X, 'single')
        fig, ax = plt.subplots()
        dn = dendrogram(Z)
        ax.set_title("Cluster {}".format(i))
        for j, cluster in g.groupby('Name of Cluster'):
```

```
                X2 = []
                for _, node in cluster.groupby('Nodes in Cluster'):
                    for u,uu in node.iterrows():
                        X2.append([uu['Value of Each Node']])
                Z = linkage(X2, 'single')
                fig, ax = plt.subplots()
                ax.set_title("{}:{}".format(i,j))
                dn = dendrogram(Z)
            break
    plt.show()
```

9. Building RK Models from Hierarchy

In [19]:
```
visualizer.plot_network()
print(inspect.getsource(visualizer.plot_network))
```

```
/workspace/rk_gw_mma/rk_visualizer.py:389: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
ted since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The de
fault value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is consi
stent with other Axes classes.
  ax = Axes3D(fig)
No handles with labels found to put in legend.
Adding node to cluster Mass 1 (Ma1)_0:2b206256-aeaf-491f-8ff3-d34724ebf2ee
Adding node to cluster Mass 1 (Ma2) _0:f332b172-d808-4107-8c7f-726dbf3a7b1b
Adding node to cluster Mass 1 (Ma3) _0:3ca77fd4-69b2-444e-94fb-da2b8c21c9d9
Adding node to cluster Mass 2 (Mb1)_0:2566b4bf-6f6c-480e-85a0-8fb8edbf28f7
Adding node to cluster Mass 2 (Mb2)_0:4098e5a4-f9da-4c22-94da-5bfea699dc08
Adding node to cluster Mass 2 (Mb3)_0:95c7f3b6-60b0-432b-ad96-9058d1f27023
Adding node to cluster Total Mass (TM1)_0:f268d65d-81e3-4f47-817f-16e965cf0b7f
Adding node to cluster Total Mass (TM2)_0:8f5c3833-7b27-4ddc-973c-258bbed11535
Adding node to cluster Total Mass (TM3)_0:2909dfd1-f24d-46a8-b6de-a32dfdac1f83
Adding node to cluster Chirp Mass (CM1)_0:3bdff0ba-d96a-4e00-b879-911f3b84bc43
Adding node to cluster Chirp Mass (CM2)_0:308ae6b1-8316-4d4d-a499-528c852b1845
Adding node to cluster Chirp Mass (CM3)_0:da94662d-1e8c-4ecb-884c-b6c3124e12bf
Adding node to cluster Final Mass (FM1)_0:2d02a4bc-5534-45ce-9c25-c174a533f7d9
Adding node to cluster Final Mass (FM2)_0:6f94d688-bbba-4295-add1-b100c4c37d0f
Adding node to cluster Final Mass (FM3)_0:e102a713-2ad8-407e-a829-30a85642c19e
RK Cluster has 105 edges for 15 nodes. Edge count 105. NPairs
Adding node to cluster Q-Value (Q1)_0:a3d3b52d-da64-49fb-b282-ca8d1635f22b
Adding node to cluster Q-Value (Q2)_0:e7442c16-161a-46d1-9653-a54e4720c281
Adding node to cluster Q-Value (Q3)_0:6d03be62-d7ca-47c7-b41a-8037996d94cd
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Source Redshift (SR1)_0:0baf8f16-b2af-4883-9fb7-080a8e8e51b6
Adding node to cluster Source Redshift (SR1)_0:85caece5-b88e-4a47-8687-71f6c4b1cf24
Adding node to cluster Source Redshift (SR1)_0:66015eed-a89d-44a4-bbed-481930aa9e90
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Inspiral (IS1)_0:8b88b34e-04b2-4ea7-882f-8a9676c18384
Adding node to cluster Inspiral (IS2)_0:9a47cd54-1050-4ea4-8a70-c147171032f8
Adding node to cluster Inspiral (IS3)_0:7c32c4e6-9edf-4c34-a0b4-43aa9e7f565c
Adding node to cluster Final Spin (FS1)_0:709e102e-79d4-461a-8bc0-8e2559547ea1
Adding node to cluster Final Spin (FS2)_0:ba21f584-badb-4bb2-85f9-c7b59992ebfa
Adding node to cluster Final Spin (FS3)_0:6e445b5b-02de-48c8-bee7-b792634a8cf9
RK Cluster has 15 edges for 6 nodes. Edge count 15. NPairs
Adding node to cluster Mass 1 (Ma1)_0:2ae3163b-9aea-4e93-86a3-6da511de5348
Adding node to cluster Mass 1 (Ma2) _0:aa675e51-8305-4c70-8176-ce9ebd32647f
Adding node to cluster Mass 1 (Ma3) _0:6113c9a3-00a2-48aa-a4e6-3da44e813586
Adding node to cluster Mass 2 (Mb1)_0:824a907c-ccc3-4fdc-b9f3-de2d0958af7b
Adding node to cluster Mass 2 (Mb2)_0:3e736066-4a77-444e-875b-a55b9551e54e
Adding node to cluster Mass 2 (Mb3)_0:d4b25740-3fef-462e-b5fc-edde550747c0
Adding node to cluster Total Mass (TM1_0:990e39d1-fb40-4584-abac-aec3acdbc26d
Adding node to cluster Total Mass (TM2)_0:b0e43488-8ab3-4a44-ac52-ff71684d6c52
Adding node to cluster Total Mass (TM3)_0:3fce2ca6-9226-4ecc-8ca8-ceca974355e5
Adding node to cluster Chirp Mass (CM1)_0:34715660-8e3c-4250-a2af-21f6ae5de5ef
Adding node to cluster Chirp Mass (CM2)_0:ea95341d-b794-4a3d-8760-c437ffa6a9b5
Adding node to cluster Chirp Mass (CM3)_0:f9c4e0ca-ebf7-4145-b5f9-fb03e357e1c8
Adding node to cluster Final Mass (FM1)_0:5b7b929c-1a5f-4ea6-bd5a-638f8ac2006c
Adding node to cluster Final Mass (FM2)_0:ab917a6d-c43b-410b-8fe7-4b278254f770
Adding node to cluster Final Mass (FM3)_0:4ff81d17-78a1-4ebd-b455-becc57228f36
RK Cluster has 105 edges for 15 nodes. Edge count 105. NPairs
Adding node to cluster Q-Value (Q1)_0:16776ad5-805a-4f93-a337-789d5229cb7b
Adding node to cluster Q-Value (Q2)_0:4b4046e0-4c11-4558-a0ec-a176bce11b4c
Adding node to cluster Q-Value (Q3)_0:9d050242-7e01-489c-bef5-a06090b9b03a
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Source Redshift (SR1)_0:868572aa-0ccb-4119-877f-ea621b1b994a
Adding node to cluster Source Redshift (SR1)_0:58c4435a-4dbb-4409-88ff-5396df181ec2
Adding node to cluster Source Redshift (SR1)_0:f12827d7-ebe5-4eaa-b1bb-0bd4da3bdb15
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Inspiral (IS1)_0:5935d5af-ceb5-4a35-997d-7775539af058
Adding node to cluster Inspiral (IS2)_0:3664d6de-e45e-4b4a-ac75-9297c8041c05
Adding node to cluster Inspiral (IS3)_0:afb22d20-95c7-4cb1-b1be-75f9df1016ad
Adding node to cluster Final Spin (FS1)_0:53df60e5-9af6-45ed-8d5d-c552f3ee0f53
Adding node to cluster Final Spin (FS2)_0:5cc150a8-8021-4584-8741-dd600a4514d8
Adding node to cluster Final Spin (FS3)_0:711189f7-844d-4983-b6fd-cd28ccc9644b
RK Cluster has 15 edges for 6 nodes. Edge count 15. NPairs
Adding node to cluster Mass 1 (Ma1)_0:171ae967-148d-4eef-8129-0b4baad22259
Adding node to cluster Mass 1 (Ma2) _0:3993231d-f9cd-4c0c-9748-d5d8f7e98a9d
Adding node to cluster Mass 1 (Ma3) _0:8e7f59e5-d8f1-4ea4-b53e-46cb41303129
Adding node to cluster Mass 2 (Mb1)_0:5c30df8f-5ad8-4566-9155-39f39bb38dff
Adding node to cluster Mass 2 (Mb2)_0:1f779fb8-3dc6-422b-b517-489966eadfdb
Adding node to cluster Mass 2 (Mb3)_0:3ee8e149-9363-44f7-aa46-6ca1b2e848a2
Adding node to cluster Total Mass (TM1_0:cc027758-0a43-46c8-b6c1-ce46bc16f851
Adding node to cluster Total Mass (TM2)_0:c8961782-b7af-44a4-9292-0d87956e026d
Adding node to cluster Total Mass (TM3)_0:f38ce686-87ac-48d6-bb0f-a11edc57ddc8
Adding node to cluster Chirp Mass (CM1)_0:268310c4-6cf5-4f81-ae3e-e4def893e118
Adding node to cluster Chirp Mass (CM2)_0:8a1b875d-e86f-4a5a-9e6e-f6b77e4b1af9
Adding node to cluster Chirp Mass (CM3)_0:76478d15-2c94-4c10-b503-ae9235fbe6ed
Adding node to cluster Final Mass (FM1)_0:44cafc11-3c67-4e29-a925-be6fedf02f47
Adding node to cluster Final Mass (FM2)_0:1b1e1acf-cac0-46bd-b25d-97f9d74b1068
Adding node to cluster Final Mass (FM3)_0:85752c51-8279-44d9-bb37-02d78f9cbcf5
RK Cluster has 105 edges for 15 nodes. Edge count 105. NPairs
```

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RK Cluster has 105 edges for 15 nodes. Edge count 105. NPairs
Adding node to cluster Q-Value (Q1)_0:a75f97e9-30c6-4adf-87df-a2883ecb4fb7
Adding node to cluster Q-Value (Q2)_0:a5b1addb-e2e3-44bf-9062-c95cec6583c9
Adding node to cluster Q-Value (Q3)_0:0d272891-6bfa-4c83-b03f-6d836cd41228
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Source Redshift (SR1)_0:d14f8c68-b1a5-417e-b1a0-966116039c7f
Adding node to cluster Source Redshift (SR1)_0:1bf66bf0-1268-4dc0-a0a5-ad0ae5c75124
Adding node to cluster Source Redshift (SR1)_0:02dd6678-2331-47bf-9216-3692a68cb77b
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Inspiral (IS1)_0:73bde213-3259-4463-8375-d05dde8f11b3
Adding node to cluster Inspiral (IS2)_0:83d1b11b-854f-4a2e-b59e-170d12a77847
Adding node to cluster Inspiral (IS3)_0:5b3deba5-66b2-41f7-b4be-95f905b6a154
Adding node to cluster Final Spin (FS1)_0:56a86a30-6af5-4fd7-b37b-114630e44e94
Adding node to cluster Final Spin (FS2)_0:dabc313a-79d6-4d9f-8bca-a67337993ddf
Adding node to cluster Final Spin (FS3)_0:8c2289bc-9e5a-471a-9d09-e6e6294d9f92
RK Cluster has 15 edges for 6 nodes. Edge count 15. NPairs
Adding node to cluster Mass 1 (Ma1)_0:9824fe6f-4f6b-4aa6-b0d1-e836895b139d
Adding node to cluster Mass 1 (Ma2) _0:7395f6c1-2b05-479b-8d3c-1f7c09d353cd
Adding node to cluster Mass 1 (Ma3) _0:30d52162-79f5-450e-8dd1-9daec6fc86f1
Adding node to cluster Mass 2 (Mb1)_0:dc5a00be-94fe-4aaf-a40a-639d8acdfddb
Adding node to cluster Mass 2 (Mb2)_0:e8d667eb-e421-4ce6-8988-ffe8cf0de3ad
Adding node to cluster Mass 2 (Mb3)_0:fe9cc63e-3176-4d60-839b-0e1e4b56c1b6
Adding node to cluster Total Mass (TM1_0:5dcaf2e9-4278-4adb-82ad-36c54a244e17
Adding node to cluster Total Mass (TM2)_0:a8f2b412-fbca-4896-a214-6677d720317b
Adding node to cluster Total Mass (TM3)_0:d368486c-78cf-463e-9f7e-a88c358b3201
Adding node to cluster Chirp Mass (CM1)_0:8deb3c0a-7e41-45d5-ae97-f4960296c95e
Adding node to cluster Chirp Mass (CM2)_0:22cabb70-970a-44c5-a3a8-241ececf743f
Adding node to cluster Chirp Mass (CM3)_0:e08106e4-970f-4dc5-a9cf-395786133fad
Adding node to cluster Final Mass (FM1)_0:3bdfcda8-ab68-4c7e-8b06-28f0638bb26c
Adding node to cluster Final Mass (FM2)_0:26ae4d63-c699-4670-b8de-e18df5554f0b
Adding node to cluster Final Mass (FM3)_0:586fc2a7-7673-4bb7-b090-c7b2ca3bd3eb
RK Cluster has 105 edges for 15 nodes. Edge count 105. NPairs
Adding node to cluster Q-Value (Q1)_0:000b51ef-754c-4a4a-a156-6f72eba2e0cb
Adding node to cluster Q-Value (Q2)_0:74f6c519-4c80-4f81-8702-26262ad051b0
Adding node to cluster Q-Value (Q3)_0:a47aba13-d01e-4d0a-9e21-e8cdb5712705
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Source Redshift (SR1)_0:f1ddb229-de60-43c9-be5b-c4c3b58c587f
Adding node to cluster Source Redshift (SR1)_0:10ad600c-1ead-4be8-9577-5e9e992cf47b
Adding node to cluster Source Redshift (SR1)_0:c80b87ba-8f03-4530-a99e-f261b9faa7bc
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Inspiral (IS1)_0:67ec04d6-3bb9-43c0-9442-9089536da339
Adding node to cluster Inspiral (IS2)_0:d6e41546-b4d7-40a6-a2c2-8268ddc9ed6a
Adding node to cluster Inspiral (IS3)_0:f831041e-693d-4da3-9c2c-718e7f813116
Adding node to cluster Final Spin (FS1)_0:3d0a3876-e281-458f-aac9-3565f361b11e
Adding node to cluster Final Spin (FS2)_0:631daa76-0e30-43aa-b02f-fb8b6fa5d158
Adding node to cluster Final Spin (FS3)_0:524d7d2b-0d65-49ab-902e-88a954764003
RK Cluster has 15 edges for 6 nodes. Edge count 15. NPairs
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
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Drawing 15 edges for 6 nodes
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Drawing 105 edges for 15 nodes
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Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
/workspace/rk_gw_mma/rk_visualizer.py:424: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
ted since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The de
fault value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is consi
stent with other Axes classes.
  ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
```

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sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
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default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
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  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
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default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
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sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
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default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rk_visualizer.py:424: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
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fault value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is consi
stent with other Axes classes.
  ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
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default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
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  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
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default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rk_visualizer.py:424: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
ted since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The de
fault value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is consi
stent with other Axes classes.
  ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:154: RuntimeWarning: More than 20 figures have been opened. Figures created throug
h the pyplot interface (`matplotlib.pyplot.figure`) are retained until explicitly closed and may consume too much memory.
(To control this warning, see the rcParam `figure.max_open_warning`).
  fig = plt.figure(dpi=100)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
```

```
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
```

```
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
```

```
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
```

```
/workspace/rk_gw_mma/rk_visualizer.py:424: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
ted since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The de
fault value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is consi
stent with other Axes classes.
  ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
```

```
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
```

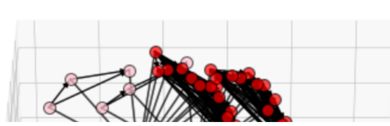
```
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:156: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax = Axes3D(fig)
/workspace/rk_gw_mma/rkmodel/rkmodels.py:171: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depr
ecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The
default value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is con
sistent with other Axes classes.
  minor_ax2 = Axes3D(fig)
```

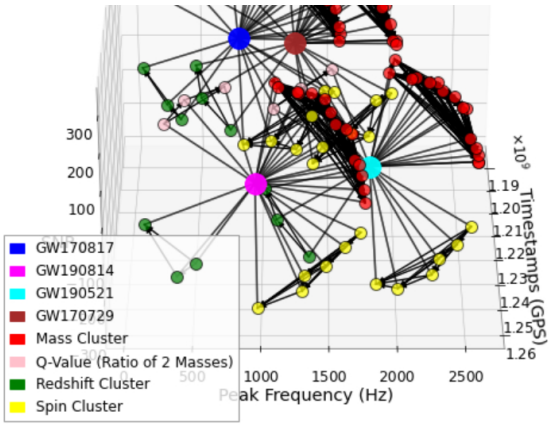
```
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
```

```
/workspace/rk_gw_mma/rkmodel/rkmodels.py:345: MatplotlibDeprecationWarning:
The M attribute was deprecated in Matplotlib 3.4 and will be removed two minor releases later. Use self.axes.M instead.
  xs, ys, zs = proj3d.proj_transform(xs3d, ys3d, zs3d, renderer.M)
```

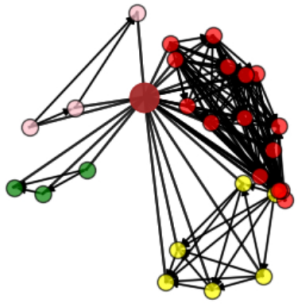
RK Diagrams

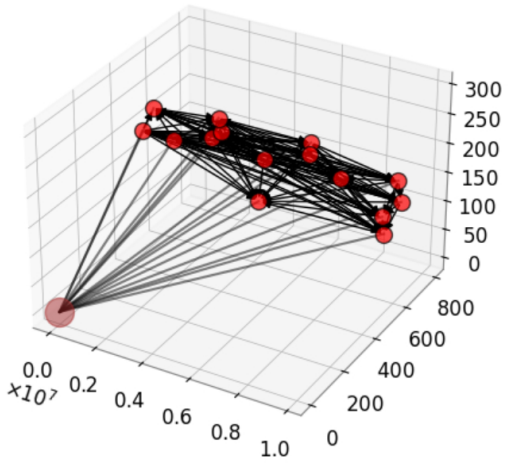
Event Scape

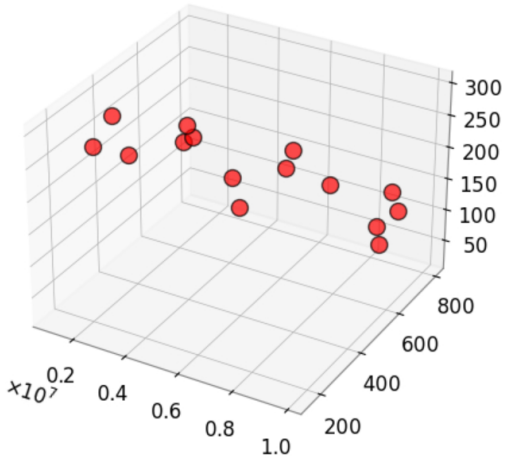


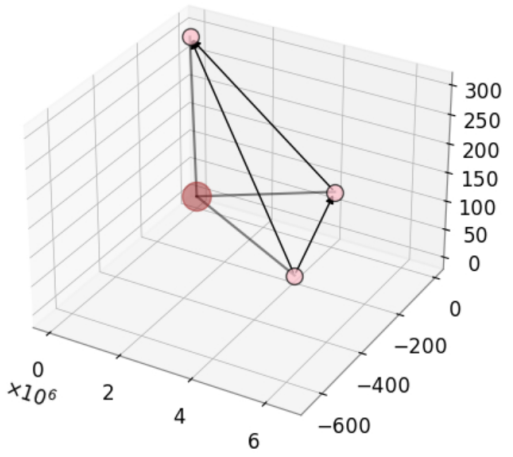

GW170817
GW190814
GW190521
GW170729
Mass Cluster
Q-Value (Ratio of 2 Masses)
Redshift Cluster
Spin Cluster
Peak Frequency (Hz)
Timestamps (GPS)
×10⁹

GW170729




×10⁷


×10⁷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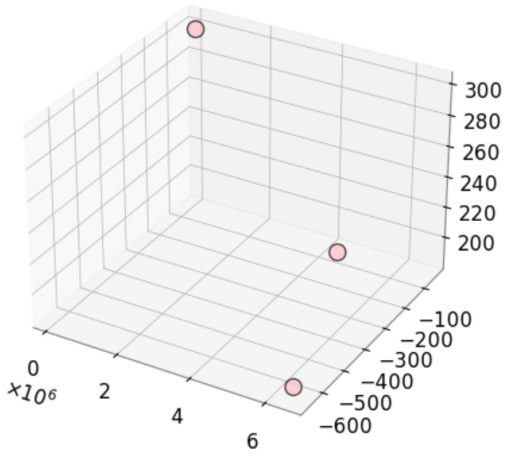
4
6
x10⁶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−100
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−500
−600
0
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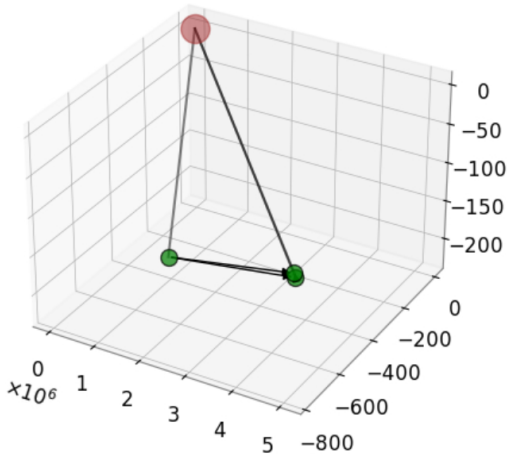
x10⁶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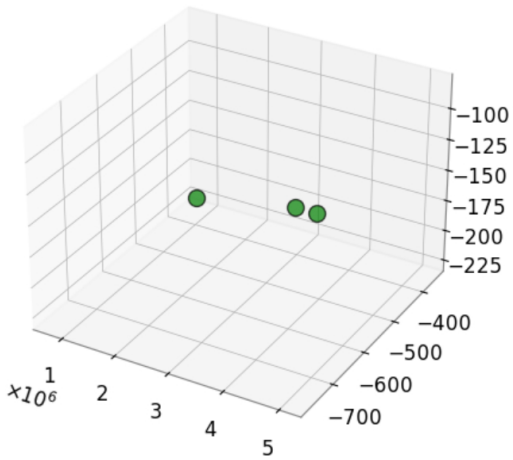
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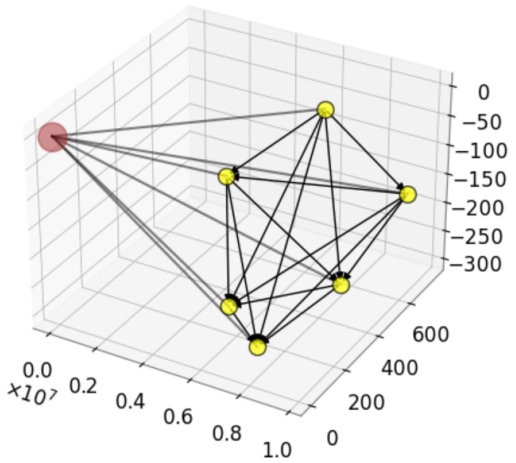
x10⁶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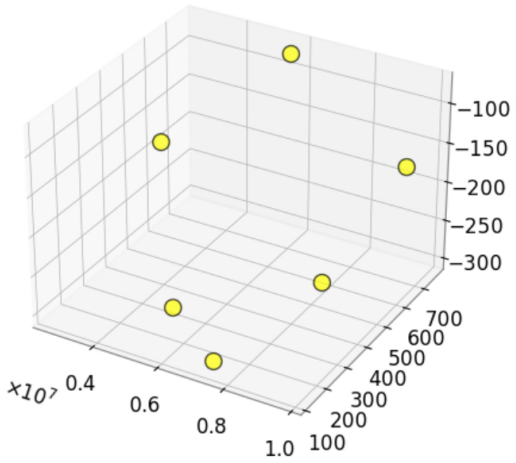
1.0
x10⁷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0.8
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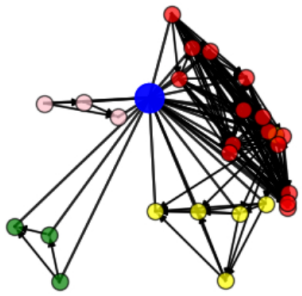
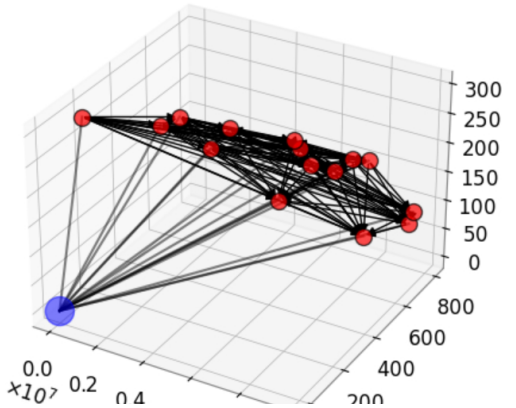
x10⁷

GW170817

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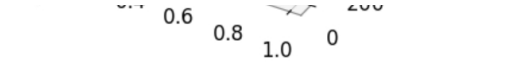
x10⁷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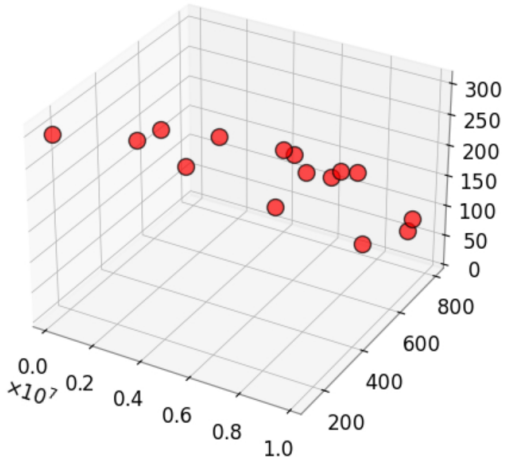
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200
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0.2
0.4
0.6
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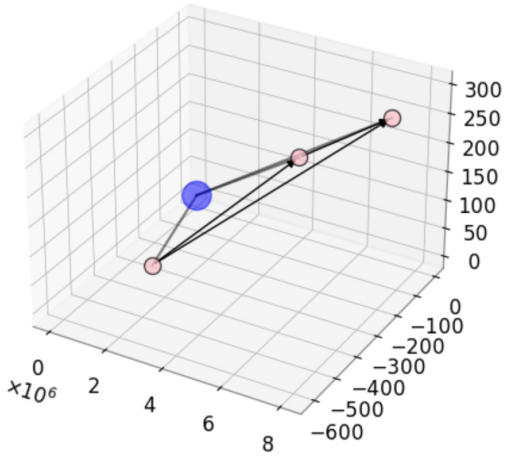
1.0
×10⁷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−600
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2
4
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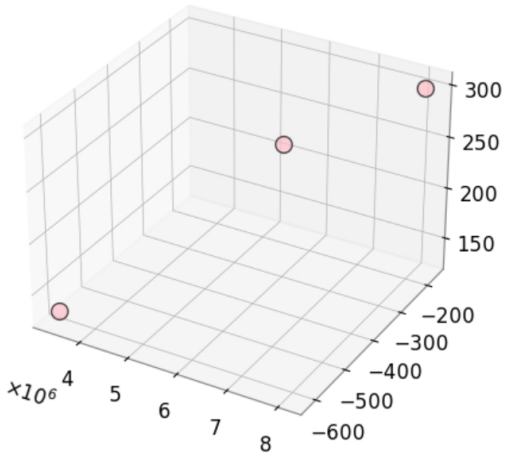
8
×10⁶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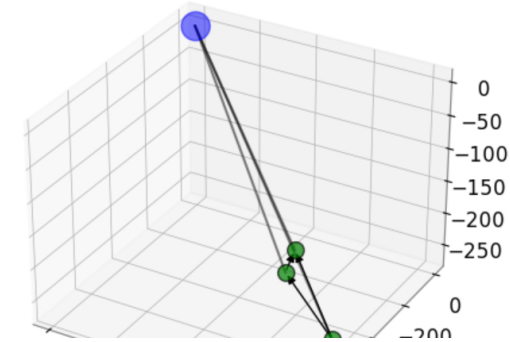
×10⁶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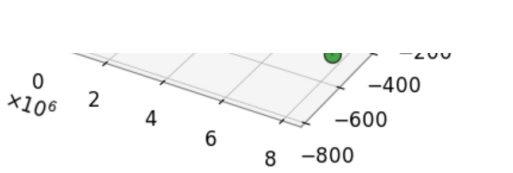
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x10⁶
2
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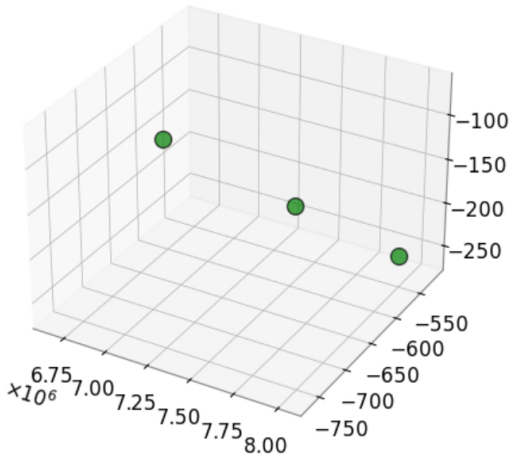
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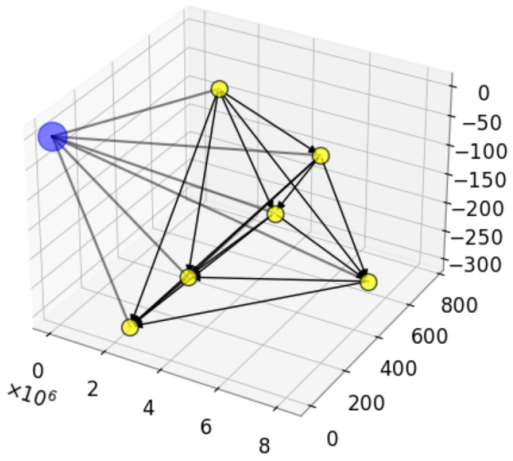
7.75
8.00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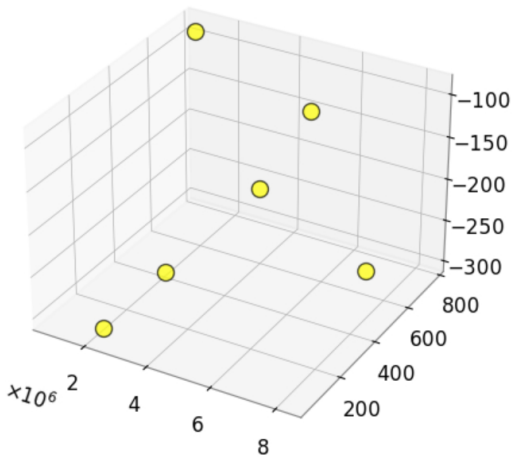
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x10⁶
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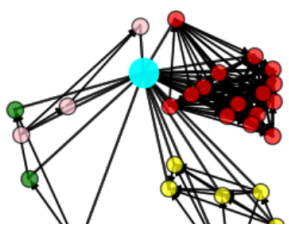
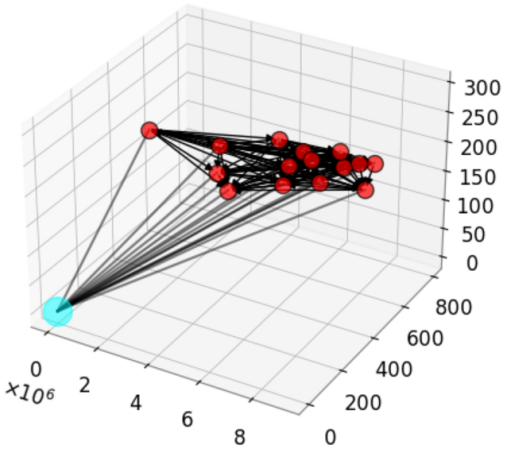
GW190521

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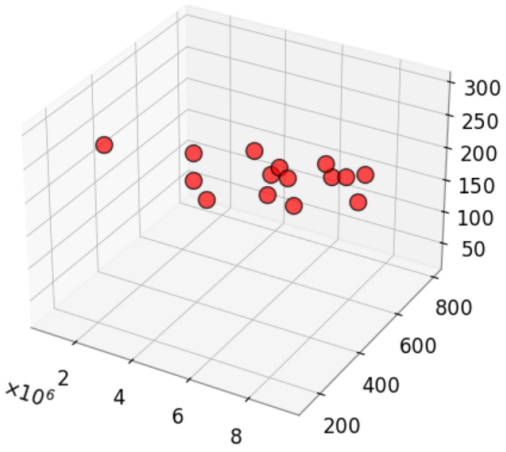
x10⁶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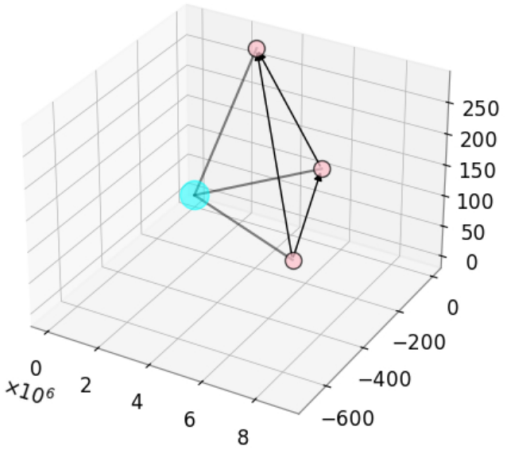
8
x10⁶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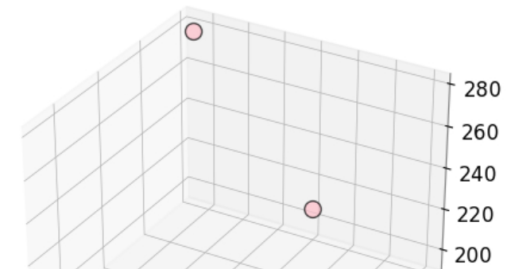
x10⁶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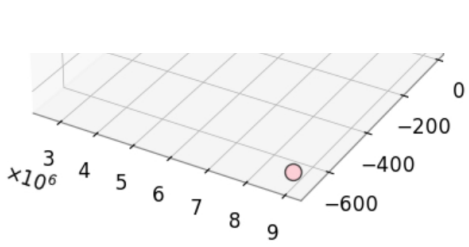
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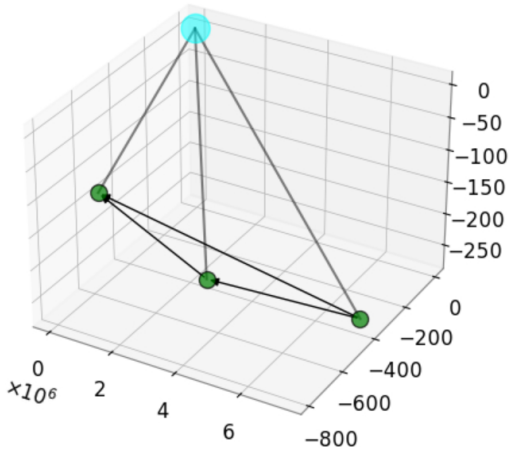
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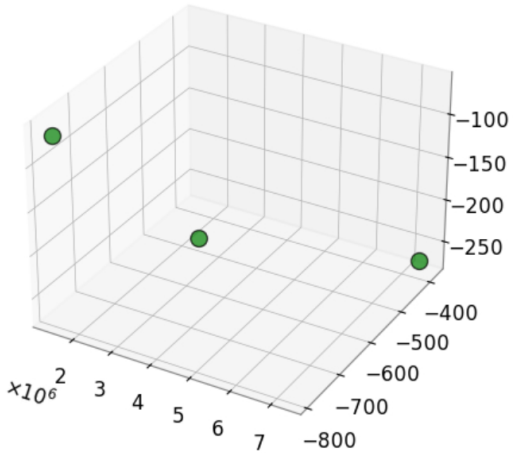
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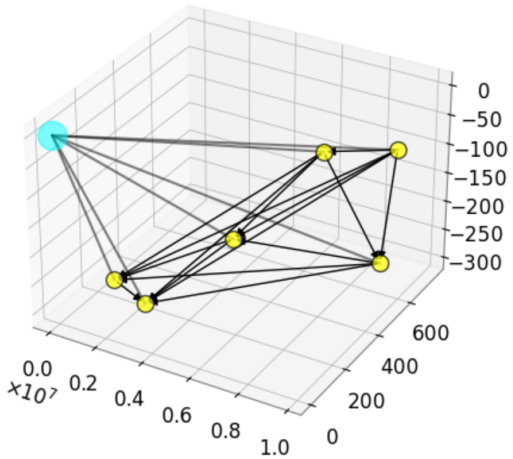
x10⁶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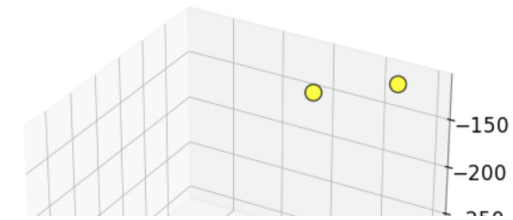
0.8
1.0
x10⁷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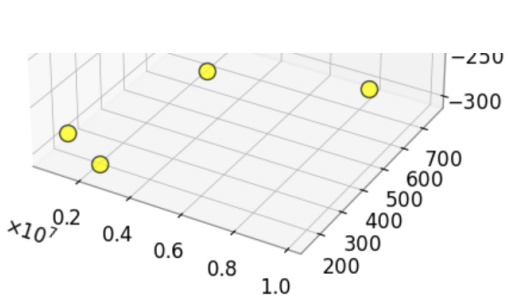
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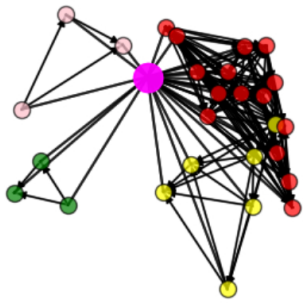
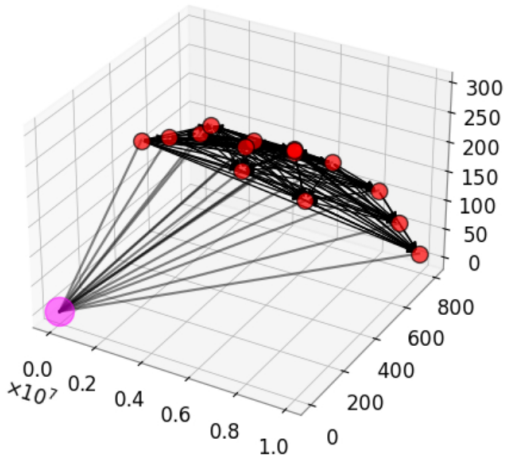
0.8
1.0
x10⁷

GW190814

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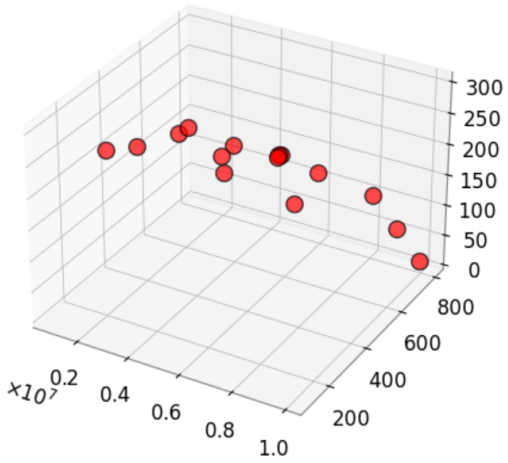
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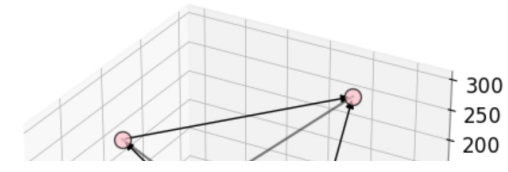
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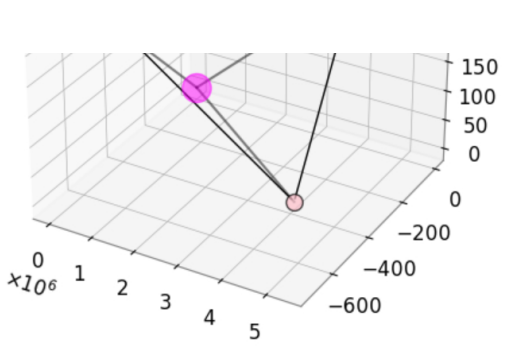
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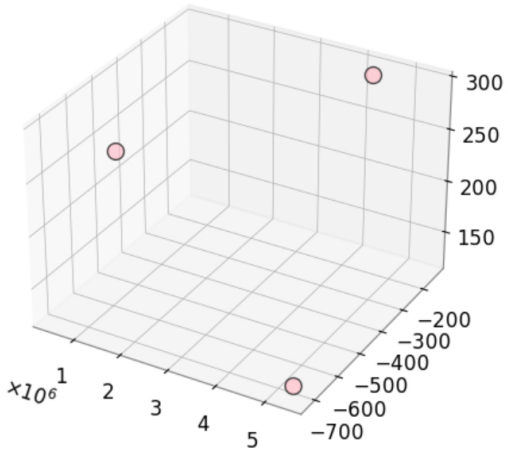
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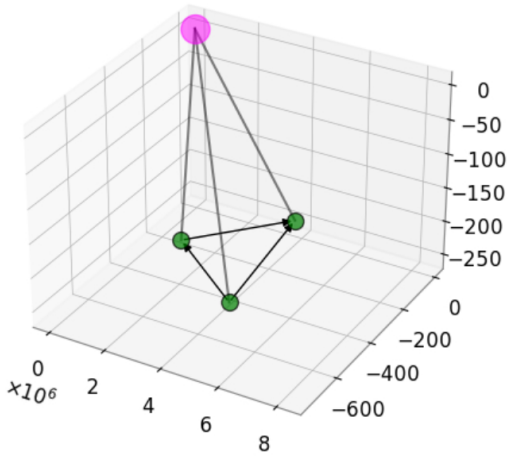
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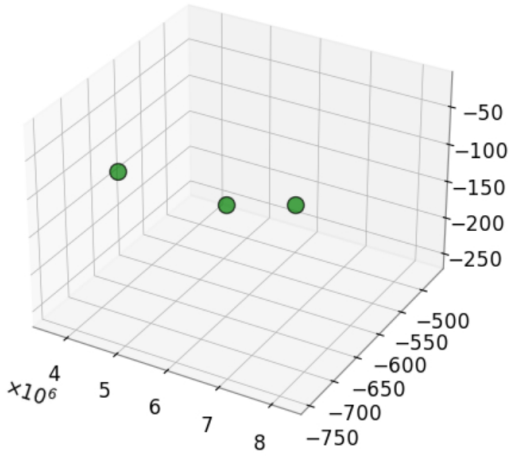
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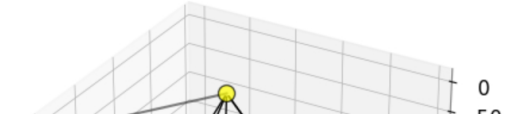
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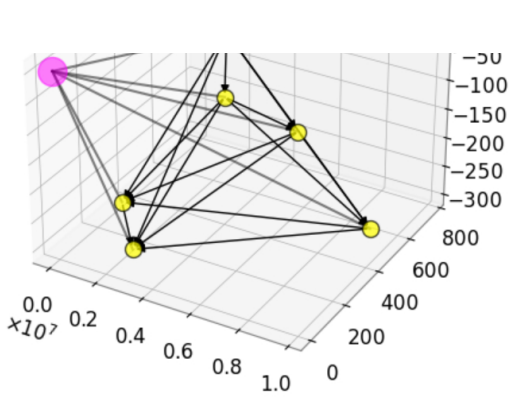

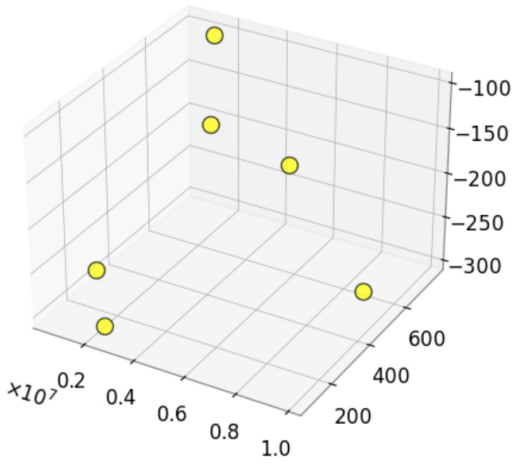


```
    def plot_network(self):
        df = pd.read_csv("ligo_classifications2.csv")
        event_info = {
            'GW170817': {'ts': 1187008882,
                         'pf': 800,
                         'snr': 33.2},
            'GW190814': {'ts': 1249852257,
                         'pf': 960,
                         'snr': 25.6},
            'GW190521': {'ts': 1242442967,
                         'pf': 1800,
                         'snr': 22.4},
            'GW170729': {'ts': 1185389807,
                         'pf': 1240,
                         'snr':10.2
            }
        }

        model = EventScape()
        for event_name, eventdf in df.groupby('Event name '):

            event = RKEvent(name=event_name, attributes=event_info[event_name])
            model.add_event(event)

            for cluster_name, clusterdf in eventdf.groupby('Name of Cluster'):

                rk_cluster = RKCluster(name=event_name)
                event.add_cluster(rk_cluster)
                all_nodes = []
                # add nodes
                for _, nodedf in clusterdf.iterrows():
                    name = nodedf['Nodes in Cluster']
                    att =  {
                        'value': nodedf['Value of Each Node'],
                        'event': nodedf['Event name '],
                        'name_of_cluster': nodedf['Name of Cluster'],
                        'name': name,
                        "ts": event_info[event_name]['ts'],
                        "pf": event_info[event_name]['pf']
                    }


                    #fthresh = [lambda x: 'Q-Value' in x.attributes['name'] and x.value < 0.4, lambda x: 'Spin' in x.attrib
utes['name'] and x.value < 1]
                    nfilter = self.master.toolbar.filters[att['name_of_cluster']] #[lambda x: 'Q-Value' in x.attributes['na
me'] and x.value < 0.4, lambda x: 'Spin' in x.attributes['name'] and x.value < 1]
                    passes = True

                    if passes:
                        value = att['value']
                        nodes_to_add = 1

                        if nfilter.is_active() and nfilter.sensitivity is not None:
                            n =  int(np.floor((value - nfilter.min()) /  nfilter.sensitivity()))
                            if n < 0:
                                raise ValueError("Error: nodes to add is negative")
                            nodes_to_add += n
```

```
                        import uuid
                        for i in range(nodes_to_add):
                            node = Node(label=name + "_" + str(i), id=uuid.uuid4(), value = att['value'], attributes=att)
                            print("Adding node to cluster {}:{}".format(node.label, node.get_id()))
                            rk_cluster.add_node(node)
                            all_nodes.append(node)
                    else:
                        print("Does not pass")

                # add edges. fully connected
                nodes = rk_cluster.get_nodes()
                pairs = set()
                edge_count = 0
                for n1 in nodes:
                    for n2 in nodes:
                        if n1.get_id() == n2.get_id():
                            continue
                        ids = sorted([n1.get_id(), n2.get_id()])
                        pid = "{}".format(ids)
                        if pid in pairs:
                            continue
                        pairs.add(pid)
                        ret = (n1, n2) if n1.value > n2.value else (n2, n1)
                        rk_cluster.add_edge(Edge(n1.get_id(), n2.get_id()))
                        edge_count+=1
                print("RK Cluster has {} edges for {} nodes. Edge count {}. NPairs".format(len(rk_cluster.get_edges()), len
(nodes), edge_count, len(pairs)))


        xyz = self.master.toolbar.xyz
        fig = plt.figure(figsize=(10,7))
        ax = Axes3D(fig)
        ax = plt.gca()

        ax.set_xlabel('Timestamps (GPS)')
        ax.set_ylabel('Peak Frequency (Hz)')
        ax.set_zlabel('SNR')
        ax.set_title("RK Diagrams")
        ax.legend()
        angle = 0

        if self.master.toolbar.xyz.use_threshold():
            xticks = np.linspace(1185389807.3, 1449852257.0, 10)
            yticks = np.linspace(0,3000, 10)
            X, Y = np.meshgrid(xticks, yticks)
            thresh = self.master.toolbar.xyz.threshold()
            if thresh is not None:
                L = np.ones(X.shape) * thresh
                ax.plot_wireframe(X, Y, L, color='red')
            else:
                print("Thresh not set")

        ax.view_init(30, angle)
        model.visualize(ax, distance_from_center=self.master.toolbar.xyz.spread(), center_size=self.master.toolbar.xyz.clus
tersize(), x=xyz.xstatus(), y=xyz.ystatus(), z=xyz.zstatus(), random=True)
        fig.suptitle("Event Scape")

        event_colors = {
            'GW170817': 'blue',
            'GW190814': 'magenta',
            'GW190521': 'cyan',
            'GW170729': 'brown'
        }

        colors = ['magenta', 'blue', 'cyan', 'brown']
        for i, event in enumerate(model.events):
            fig = plt.figure(dpi=100)
            ax = Axes3D(fig)
            ax = plt.gca()
            angle = 0
            ax.view_init(30, angle)
            plt.grid(b=None)
            plt.axis('off')
            # make the panes transparent
            ax.xaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
            ax.yaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
            ax.zaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
            # make the grid lines transparent
            ax.xaxis._axinfo["grid"]['color'] =  (1,1,1,0)
            ax.yaxis._axinfo["grid"]['color'] =  (1,1,1,0)
            ax.zaxis._axinfo["grid"]['color'] =  (1,1,1,0)
            event.visualize(ax, distance_from_center=self.master.toolbar.xyz.spread(), center_color=event_colors[event.nam
e], show_legend=False, random=True, show_minor=True)
            fig.suptitle(event.name)

        plt.show()
```

10 Apply Linkers and Filters to the R-K Model and Plot Final R-K Diagrams

In [20]:

```
visualizer.plot_rk_diagrams()
print(inspect.getsource(visualizer.plot_rk_diagrams))
```

```
/workspace/rk_gw_mma/rk_visualizer.py:567: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
ted since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The de
fault value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is consi
stent with other Axes classes.
  ax = Axes3D(fig)
No handles with labels found to put in legend.
```

```
Adding node to cluster Mass 1 (Ma1)_0:a7bb5818-28c9-4333-9e89-7b44822d8dd1
Adding node to cluster Mass 1 (Ma2) _0:f2e8bd93-0b9e-49a6-aed9-133abde7415f
Adding node to cluster Mass 1 (Ma3) _0:8a10e8c2-da5a-4468-8ba1-c7128e5fa528
Adding node to cluster Mass 2 (Mb1)_0:4c0759e1-7fd1-4bd1-b11f-98c337720cac
Adding node to cluster Mass 2 (Mb2)_0:3efc45d0-59f6-4869-ae59-34f8330642fe
Adding node to cluster Mass 2 (Mb3)_0:1442831e-6008-4156-a8f5-a08916c902f1
Adding node to cluster Total Mass (TM1)_0:44b4af8b-8a81-4ac9-986d-4e094920bb78
Adding node to cluster Total Mass (TM2)_0:b0f55cb6-9aed-49ea-9c23-5ff08b576254
Adding node to cluster Total Mass (TM3)_0:fa9f4362-36c7-4a73-babb-cb8a32b87745
Adding node to cluster Chirp Mass (CM1)_0:48305873-ae10-4620-a345-ba26368cf2bc
Adding node to cluster Chirp Mass (CM2)_0:b6be20d0-d86c-41b2-a22d-0ff1adae5374
Adding node to cluster Chirp Mass (CM3)_0:86f18eb6-5f9b-4931-8304-94d17a774a20
Adding node to cluster Final Mass (FM1)_0:5ecbee3f-04e1-4773-b624-324a8a07ff98
Adding node to cluster Final Mass (FM2)_0:cabf32f6-82d4-4839-91de-84a59a0abf7d
Adding node to cluster Final Mass (FM3)_0:c9bb7643-69cf-4502-b254-ca4d54b49379
RK Cluster has 105 edges for 15 nodes. Edge count 105. NPairs
Adding node to cluster Q-Value (Q1)_0:30e24d29-5912-403b-8850-cbdbfb13259b
Adding node to cluster Q-Value (Q2)_0:438c9e85-c8c4-4c39-820f-da6162102d78
Adding node to cluster Q-Value (Q3)_0:c3e74987-043e-4047-8a29-6868a3d690cd
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Source Redshift (SR1)_0:06139877-715d-40a4-aa3f-d2a8b5df9630
Adding node to cluster Source Redshift (SR1)_0:fbccbcb1-4bb2-4ee8-a778-6d155a9162ae
Adding node to cluster Source Redshift (SR1)_0:8b10920e-0139-4279-a6ce-22f98f1eb543
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Inspiral (IS1)_0:8374e62b-2feb-4f8b-bfbc-33ad7e7fb51a
Adding node to cluster Inspiral (IS2)_0:4ad475a3-83f8-4a9d-a365-cab6d1ef7303
Adding node to cluster Inspiral (IS3)_0:dae535fd-bc95-4ea0-a142-1375840cdd01
Adding node to cluster Final Spin (FS1)_0:523ea0c4-5369-4b5c-a941-79810f151d1e
Adding node to cluster Final Spin (FS2)_0:9e153c5d-a0f8-45de-8de2-3f81aef125d1
Adding node to cluster Final Spin (FS3)_0:fd703f80-541d-4568-84b6-9034562db22e
RK Cluster has 15 edges for 6 nodes. Edge count 15. NPairs
Adding node to cluster Mass 1 (Ma1)_0:3b0a3edf-faed-4ac0-a3f6-a89a05aad474
Adding node to cluster Mass 1 (Ma2) _0:bc9cc3bd-623d-4bcc-9eb0-e26dc17e94a5
Adding node to cluster Mass 1 (Ma3) _0:454ad64b-476a-4c5c-a149-012e075c3911
Adding node to cluster Mass 2 (Mb1)_0:1087dd64-ba7f-4df9-9d50-0a9f3b4bf851
Adding node to cluster Mass 2 (Mb2)_0:7be4d29b-39a4-4ae9-8673-a708b504e72a
Adding node to cluster Mass 2 (Mb3)_0:ddc78bf4-b9ca-4d15-a8ae-d7c6d39e6b5a
Adding node to cluster Total Mass (TM1_0:2b887760-f96f-4fb1-af8e-a95e1bbd3bc0
Adding node to cluster Total Mass (TM2)_0:81f2dd02-8dfc-4c17-a839-cc087d3f214e
Adding node to cluster Total Mass (TM3)_0:d5b34b07-7876-4604-b71d-5bbc2386ebd5
Adding node to cluster Chirp Mass (CM1)_0:af46510e-2d80-471e-b7aa-ede6f3d041f8
Adding node to cluster Chirp Mass (CM2)_0:e6ae6ac1-e91a-49e9-8a4d-546b9dd420f8
Adding node to cluster Chirp Mass (CM3)_0:240ca859-3932-40f7-b1ff-d2f11dffddd7
Adding node to cluster Final Mass (FM1)_0:1cadd54e-f50e-4be6-bfd1-69303dabe973
Adding node to cluster Final Mass (FM2)_0:7a18ee76-5919-4ac0-ac46-93f353659417
Adding node to cluster Final Mass (FM3)_0:64c26021-2f8d-475e-8382-38f66c7caad4
RK Cluster has 105 edges for 15 nodes. Edge count 105. NPairs
Adding node to cluster Q-Value (Q1)_0:f6b41a29-675b-4ac2-b59c-b31e775f50da
Adding node to cluster Q-Value (Q2)_0:47c43169-8e36-41f8-b66a-21b147e11143
Adding node to cluster Q-Value (Q3)_0:cf730ce9-f8d9-4afa-bd1c-8ac49dbe4c3d
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Source Redshift (SR1)_0:4114a07d-a9b2-4695-8808-4a5e43226c79
Adding node to cluster Source Redshift (SR1)_0:d7e66b2e-7280-4a60-97a9-753a0b99446a
Adding node to cluster Source Redshift (SR1)_0:e5d19aca-0dd1-4877-a02c-e850bba1ab06
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Inspiral (IS1)_0:12af6d7b-9ac9-4ff5-ad58-be7acb84041e
Adding node to cluster Inspiral (IS2)_0:5a073935-e95d-4d4f-947b-d8abc250cbc2
Adding node to cluster Inspiral (IS3)_0:8f3b1e6f-32c3-4c45-bf47-26d4e19029da
Adding node to cluster Final Spin (FS1)_0:2ba3d492-3c0a-4121-a392-98d2d97f3961
Adding node to cluster Final Spin (FS2)_0:745e9fc5-4ff6-4b0d-b49b-7ce475585ffa
Adding node to cluster Final Spin (FS3)_0:387eb686-5249-444b-a29d-d74b7265f2ac
RK Cluster has 15 edges for 6 nodes. Edge count 15. NPairs
Adding node to cluster Mass 1 (Ma1)_0:625d37ba-9c65-4e43-b457-3952b9dbdcd5
Adding node to cluster Mass 1 (Ma2) _0:3d1e8e55-9ac1-4c80-b019-ac54ce108b34
Adding node to cluster Mass 1 (Ma3) _0:2e6e4d54-1e46-4a51-9f09-c9f6dc44f006
Adding node to cluster Mass 2 (Mb1)_0:367f99b2-677f-412a-bc6f-d127d6a4e623
Adding node to cluster Mass 2 (Mb2)_0:f38d3559-ee34-45d2-9a31-90c446a25dd2
Adding node to cluster Mass 2 (Mb3)_0:026cae24-b1e4-4579-b3d9-293f5ee0df37
Adding node to cluster Total Mass (TM1_0:c93cb4ec-8c1b-459d-9474-6ceef51aac53
Adding node to cluster Total Mass (TM2)_0:4dbe358e-0e61-4f31-9000-fe964db487cf
Adding node to cluster Total Mass (TM3)_0:948836c8-61ee-4011-8101-815831fd8af0
Adding node to cluster Chirp Mass (CM1)_0:96bb6372-8670-4da4-8576-f36ece097217
Adding node to cluster Chirp Mass (CM2)_0:8167d12c-1dfb-424a-a64f-0b65e57a6396
Adding node to cluster Chirp Mass (CM3)_0:d9b6a856-34d6-478a-b1d6-b4ebb0cf58c8
Adding node to cluster Final Mass (FM1)_0:b4a2abdf-3778-4b30-84e0-39893ad4b787
Adding node to cluster Final Mass (FM2)_0:07b69c75-b4e3-41b5-930e-c1c2b4f082d8
Adding node to cluster Final Mass (FM3)_0:bfaace7d-4024-4e25-8f6e-7ec4a7ffc534
RK Cluster has 105 edges for 15 nodes. Edge count 105. NPairs
Adding node to cluster Q-Value (Q1)_0:c46383a6-fb57-433e-81cf-a94f8c349e65
Adding node to cluster Q-Value (Q2)_0:912c376f-facd-4cd9-8c61-7931cf95bbd5
Adding node to cluster Q-Value (Q3)_0:13f39f4f-a7f1-4ae7-ba0b-311916f8d6eb
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Source Redshift (SR1)_0:d49c5347-7131-4951-b5b6-88c175154122
Adding node to cluster Source Redshift (SR1)_0:c24018d3-f1df-45cf-b962-1b3d5d149938
Adding node to cluster Source Redshift (SR1)_0:d3d947d3-737b-418a-9d26-ff10e88916a4
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Inspiral (IS1)_0:fe08b732-8603-46c6-aac7-e91b3cc9679c
Adding node to cluster Inspiral (IS2)_0:684812ef-4646-424e-afeb-7c6dcd786109
Adding node to cluster Inspiral (IS3)_0:fa25777d-c149-4556-bbd8-0375091ed392
Adding node to cluster Final Spin (FS1)_0:dd04212e-1e93-4b8b-8a09-92e407baeef0
Adding node to cluster Final Spin (FS2)_0:e6607f6e-f856-4736-ae5c-f1e01e3c1f64
Adding node to cluster Final Spin (FS3)_0:2063a1a5-fa51-4bc1-b75d-4d7fc8461278
RK Cluster has 15 edges for 6 nodes. Edge count 15. NPairs
Adding node to cluster Mass 1 (Ma1)_0:c0d4d2a1-6465-4631-99f7-e593e47cd8e1
Adding node to cluster Mass 1 (Ma2) _0:60fba89a-8766-417e-87ce-60d651ac2d0c
Adding node to cluster Mass 1 (Ma3) _0:456e4dad-fbaf-4430-9518-39166ab1245d
Adding node to cluster Mass 2 (Mb1)_0:e746df42-1619-4433-a1ae-74ead24a8e6c
Adding node to cluster Mass 2 (Mb2)_0:a60a7704-6037-4daa-b79b-ff577eb95a8a
Adding node to cluster Mass 2 (Mb3)_0:3e89ae51-37a6-42c2-a9f1-ade9f3b0ae56
Adding node to cluster Total Mass (TM1_0:07f0bc61-545a-42a5-a050-dd9df278e5d1
Adding node to cluster Total Mass (TM2)_0:d0a30738-b1d9-4afc-8f28-4189bc210930
Adding node to cluster Total Mass (TM3)_0:62cd11e8-ac76-432e-b750-3a935f914be6
Adding node to cluster Chirp Mass (CM1)_0:8a820497-4b7c-48e5-ae17-1ce47a14078c
Adding node to cluster Chirp Mass (CM2)_0:1db0de0d-85f2-4d84-9ad8-0107f139687d
```

```
Adding node to cluster Chirp Mass (CM2)_0:1db6da9d-8512-4d84-9ad8-6167f136687d
Adding node to cluster Chirp Mass (CM3)_0:e2eb94ee-e1c8-4085-b23d-b13455973f43
Adding node to cluster Final Mass (FM1)_0:c3e2b03b-2514-45a0-bfc6-3a7066345123
Adding node to cluster Final Mass (FM2)_0:8e477f57-0252-48ff-832a-1ca978004137
Adding node to cluster Final Mass (FM3)_0:c8debabe-68c2-48e7-9a4a-60c29db0d548
RK Cluster has 105 edges for 15 nodes. Edge count 105. NPairs
Adding node to cluster Q-Value (Q1)_0:354978a3-2ebb-49fa-ace7-c0154d3ea63c
Adding node to cluster Q-Value (Q2)_0:adc6cc28-20b3-4096-80e5-3276e7a6af1a
Adding node to cluster Q-Value (Q3)_0:68122cf7-da2e-4553-9867-e74250a97a85
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Source Redshift (SR1)_0:6370923c-87ba-4d03-b84c-032f76f4f6e7
Adding node to cluster Source Redshift (SR1)_0:a60a2285-f44f-4b30-92fc-e79a770115b4
Adding node to cluster Source Redshift (SR1)_0:6e4c0887-afdc-4843-9601-5ce5640f1d93
RK Cluster has 3 edges for 3 nodes. Edge count 3. NPairs
Adding node to cluster Inspiral (IS1)_0:b120c8c9-187d-4b83-b41e-4530cfd770a4
Adding node to cluster Inspiral (IS2)_0:2762ad4c-6808-4515-aafa-050f13419192
Adding node to cluster Inspiral (IS3)_0:97e7a3e1-1f34-4b05-bea3-46afbb1d83f2
Adding node to cluster Final Spin (FS1)_0:3f28ed16-66bc-46d5-8ad4-904e5d1d56d4
Adding node to cluster Final Spin (FS2)_0:5fd78d74-c265-4208-88f5-8d55e6d00205
Adding node to cluster Final Spin (FS3)_0:2228d97c-4b9a-49a3-b646-660dd05ec15c
RK Cluster has 15 edges for 6 nodes. Edge count 15. NPairs
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
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Drew 3 edges for 3 nodes
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
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Drew 3 edges for 3 nodes
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Drew 15 edges for 6 nodes
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
/workspace/rk_gw_mma/rk_visualizer.py:602: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
ted since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The de
fault value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is consi
stent with other Axes classes.
  ax = Axes3D(fig)
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
Drawing 105 edges for 15 nodes
/workspace/rk_gw_mma/rk_visualizer.py:602: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
ted since 3.4. Pass the keyword argument auto_add_to_figure=False and use fig.add_axes(ax) to suppress this warning. The de
fault value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is consi
stent with other Axes classes.
  ax = Axes3D(fig)
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
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Drew 3 edges for 3 nodes
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
/workspace/rk_gw_mma/rk_visualizer.py:602: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
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Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
/workspace/rk_gw_mma/rk_visualizer.py:602: MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is depreca
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fault value of auto_add_to_figure will change to False in mpl3.5 and True values will no longer work in 3.6.  This is consi
stent with other Axes classes.
  ax = Axes3D(fig)
Drawing 105 edges for 15 nodes
Drew 105 edges for 15 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
Drawing 3 edges for 3 nodes
Drew 3 edges for 3 nodes
```
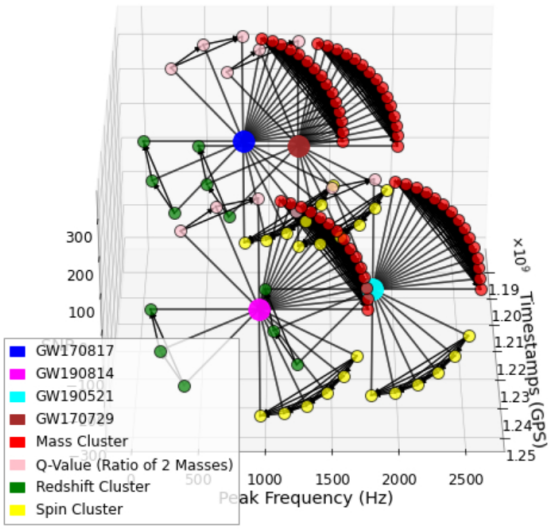
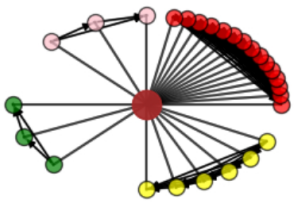

```
Drawing 15 edges for 6 nodes
Drew 15 edges for 6 nodes
/workspace/rk_gw_mma/rkmodel/rkmodels.py:345: MatplotlibDeprecationWarning:
The M attribute was deprecated in Matplotlib 3.4 and will be removed two minor releases later. Use self.axes.M instead.
  xs, ys, zs = proj3d.proj_transform(xs3d, ys3d, zs3d, renderer.M)
```

RK Diagrams

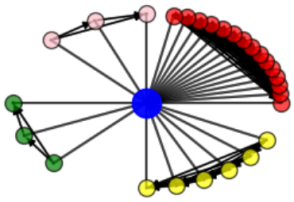
Event Scape



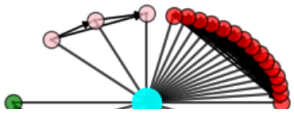
GW170729

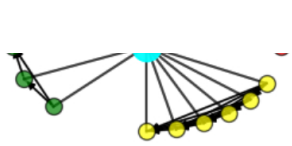


GW170817

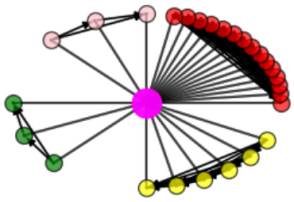


GW190521





GW190814



```
    def plot_rk_diagrams(self):

        df = pd.read_csv("ligo_classifications2.csv")
        event_info = {
            'GW170817': {'ts': 1187008882,
                         'pf': 800,
                         'snr': 33.2},
            'GW190814': {'ts': 1249852257,
                         'pf': 960,
                         'snr': 25.6},
            'GW190521': {'ts': 1242442967,
                         'pf': 1800,
                         'snr': 22.4},
            'GW170729': {'ts': 1185389807,
                         'pf': 1240,
                         'snr':10.2
            }
        }

        model = EventScape()
        for event_name, eventdf in df.groupby('Event name '):

            event = RKEvent(name=event_name, attributes=event_info[event_name])
            model.add_event(event)

            for cluster_name, clusterdf in eventdf.groupby('Name of Cluster'):

                rk_cluster = RKCluster(name=event_name)
                event.add_cluster(rk_cluster)
                all_nodes = []
                # add nodes
                for _, nodedf in clusterdf.iterrows():
                    name = nodedf['Nodes in Cluster']
                    att =  {
                        'value': nodedf['Value of Each Node'],
                        'event': nodedf['Event name '],
                        'name_of_cluster': nodedf['Name of Cluster'],
                        'name': name,
                        "ts": event_info[event_name]['ts'],
                        "pf": event_info[event_name]['pf']
                    }


                    #fthresh = [lambda x: 'Q-Value' in x.attributes['name'] and x.value < 0.4, lambda x: 'Spin' in x.attrib
utes['name'] and x.value < 1]
                    nfilter = self.master.toolbar.filters[att['name_of_cluster']] #[lambda x: 'Q-Value' in x.attributes['na
me'] and x.value < 0.4, lambda x: 'Spin' in x.attributes['name'] and x.value < 1]
                    passes = True

                    if nfilter.is_active():
                        value = att['value']
                        if nfilter.min() is not None and value < nfilter.min():
                            passes = False
                            break
                        if nfilter.max() is not None and value > nfilter.max():
                            passes = False
                            break

                    if passes:
                        value = att['value']
                        nodes_to_add = 1

                        if nfilter.is_active() and nfilter.sensitivity is not None:
                            n =  int(np.floor((value - nfilter.min()) /  nfilter.sensitivity()))
                            if n < 0:
```

```
                        if n < 0:
                            raise ValueError("Error: nodes to add is negative")
                        nodes_to_add += n

                    import uuid
                    for i in range(nodes_to_add):
                        node = Node(label=name + "_" + str(i), id=uuid.uuid4(), value = att['value'], attributes=att)
                        print("Adding node to cluster {}:{}".format(node.label, node.get_id()))
                        rk_cluster.add_node(node)
                        all_nodes.append(node)
                else:
                    print("Does not pass")

            # add edges. fully connected
            nodes = rk_cluster.get_nodes()
            pairs = set()
            edge_count = 0
            for n1 in nodes:
                for n2 in nodes:
                    if n1.get_id() == n2.get_id():
                        continue
                    ids = sorted([n1.get_id(), n2.get_id()])
                    pid = "{}".format(ids)
                    if pid in pairs:
                        continue
                    pairs.add(pid)
                    ret = (n1, n2) if n1.value > n2.value else (n2, n1)
                    rk_cluster.add_edge(Edge(n1.get_id(), n2.get_id()))
                    edge_count+=1
            print("RK Cluster has {} edges for {} nodes. Edge count {}. NPairs".format(len(rk_cluster.get_edges()), len
(nodes), edge_count, len(pairs)))

        class Arrow3D(FancyArrowPatch):
            def __init__(self, xs, ys, zs, *args, **kwargs):
                FancyArrowPatch.__init__(self, (0,0), (0,0), *args, **kwargs)
                self._verts3d = xs, ys, zs

            def draw(self, renderer):
                xs3d, ys3d, zs3d = self._verts3d
                xs, ys, zs = proj3d.proj_transform(xs3d, ys3d, zs3d, renderer.M)
                self.set_positions((xs[0],ys[0]),(xs[1],ys[1]))
                FancyArrowPatch.draw(self, renderer)
                pass

        # case where all 3

        xyz = self.master.toolbar.xyz
        fig = plt.figure(figsize=(10,7))
        ax = Axes3D(fig)
        ax = plt.gca()

        ax.set_xlabel('Timestamps (GPS)')
        ax.set_ylabel('Peak Frequency (Hz)')
        ax.set_zlabel('SNR')
        ax.set_title("RK Diagrams")
        ax.legend()
        angle = 0

        if self.master.toolbar.xyz.use_threshold():
            xticks = np.linspace(1185389807.3, 1449852257.0, 10)
            yticks = np.linspace(0,3000, 10)
            X, Y = np.meshgrid(xticks, yticks)
            thresh = self.master.toolbar.xyz.threshold()
            if thresh is not None:
                L = np.ones(X.shape) * thresh
                ax.plot_wireframe(X, Y, L, color='red')
            else:
                print("Thresh not set")

        ax.view_init(30, angle)
        model.visualize(ax, distance_from_center=self.master.toolbar.xyz.spread(), center_size=self.master.toolbar.xyz.clus
tersize(), x=xyz.xstatus(), y=xyz.ystatus(), z=xyz.zstatus())
        fig.suptitle("Event Scape")

        event_colors = {
            'GW170817': 'blue',
            'GW190814': 'magenta',
            'GW190521': 'cyan',
            'GW170729': 'brown'
        }

        colors = ['magenta', 'blue', 'cyan', 'brown']
        for i, event in enumerate(model.events):
            fig = plt.figure(dpi=100)
            ax = Axes3D(fig)
            ax = plt.gca()
            angle = 0
            ax.view_init(30, angle)
            plt.grid(b=None)
            plt.axis('off')
            # make the panes transparent
            ax.xaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
            ax.yaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
            ax.zaxis.set_pane_color((1.0, 1.0, 1.0, 0.0))
            # make the grid lines transparent
            ax.xaxis._axinfo["grid"]['color'] =  (1,1,1,0)
            ax.yaxis._axinfo["grid"]['color'] =  (1,1,1,0)
            ax.zaxis._axinfo["grid"]['color'] =  (1,1,1,0)
            event.visualize(ax, distance_from_center=self.master.toolbar.xyz.spread(), center_color=event_colors[event.nam
e], show_legend=False)
            fig.suptitle(event.name)

        plt.show()
```