

```

In [2]: import torch
        from torch import nn
        import numpy as np
        from torch.autograd import Variable
        import matplotlib.pyplot as plt

        from Forward_with_Layer_Setting import Net
        from InitialConditionLoss import InitialCondition_rho

        #####

        time_plotted = 0.1

        #####

        device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")

        net = Net().to(device)

        net.load_state_dict(torch.load("BubbleLayers_lr0.005_finaltime0.1.pt", map_location=torch.device('cpu')))

        #Graph at various time slices

        spatial_discretization = 1000

        #Define numpy arrays for inputs
        x1 = np.linspace(net.x1_l, net.x1_u, spatial_discretization).reshape(spatial_discretization)
        x2 = np.linspace(net.x2_l, net.x2_u, spatial_discretization).reshape(spatial_discretization)
        x1x2 = np.array(np.meshgrid(x1, x2)).reshape(2, spatial_discretization**2)

        t = time_plotted*np.ones((spatial_discretization**2, 1))

        x1_input = x1x2[0].reshape(spatial_discretization**2, 1)
        x2_input = x1x2[1].reshape(spatial_discretization**2, 1)

        x1x2 = [x1_input, x2_input]

        #convert to pytorch tensors
        pt_x1 = Variable(torch.from_numpy(x1_input).float(), requires_grad=False).to(device)
        pt_x2 = Variable(torch.from_numpy(x2_input).float(), requires_grad=False).to(device)

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pt_t = Variable(torch.from_numpy(t).float(), requires_grad=False).to(device)

#get network outputs
pt_u1, pt_u2, pt_p, pt_rho = net(pt_x1, pt_x2, pt_t)

#get actual initial condition
rho_exact = InitialCondition_rho(net, pt_x1, pt_x2)

#Convert back to numpy
u1, u2, p, rho = pt_u1.data.cpu().numpy(), pt_u2.data.cpu().numpy(), pt_p.data.cpu().numpy(), pt_rho.data.cpu().numpy()
rho_exact = rho_exact.data.cpu().numpy()
error = rho-rho_exact

X, Y = np.meshgrid(x1, x2)

fig, axs = plt.subplots(3 )
#fig.suptitle(f'Time = {time_plotted}')
fig.tight_layout()
axs[0].set_title("Predicted density shape at t = %.1f" % time_plotted)
axs[1].set_title('Actual Initial Density where t=0 for comparing movement')
axs[2].set_title('Error')
#axs[0].pcolor(X, Y, rho.reshape(X.shape))
#axs[1].pcolor(X, Y, rho_exact.reshape(X.shape))
#axs[2].pcolor(X, Y, error.reshape(X.shape))

# Plot both positive and negative values between +/- 1.2
pos_neg_clipped = axs[0].imshow(rho.reshape(X.shape), cmap='RdBu', vmin=-1000, vmax=1000,
                                interpolation='none', extent = (net.x1_l,net.x1_u, net.x2_u, net.x2_l))
# Add minorticks on the colorbar to make it easy to read the
# values off the colorbar.
cbar = fig.colorbar(pos_neg_clipped, ax=axs[0].invert_yaxis(), extend='both')
cbar.minorticks_on()

# Plot both positive and negative values between +/- 1.2
pos_neg_clipped = axs[1].imshow(rho_exact.reshape(X.shape), cmap='RdBu', vmin=-1000, vmax=1000,
                                interpolation='none', extent = (net.x1_l,net.x1_u, net.x2_u, net.x2_l))
# Add minorticks on the colorbar to make it easy to read the
# values off the colorbar.

```

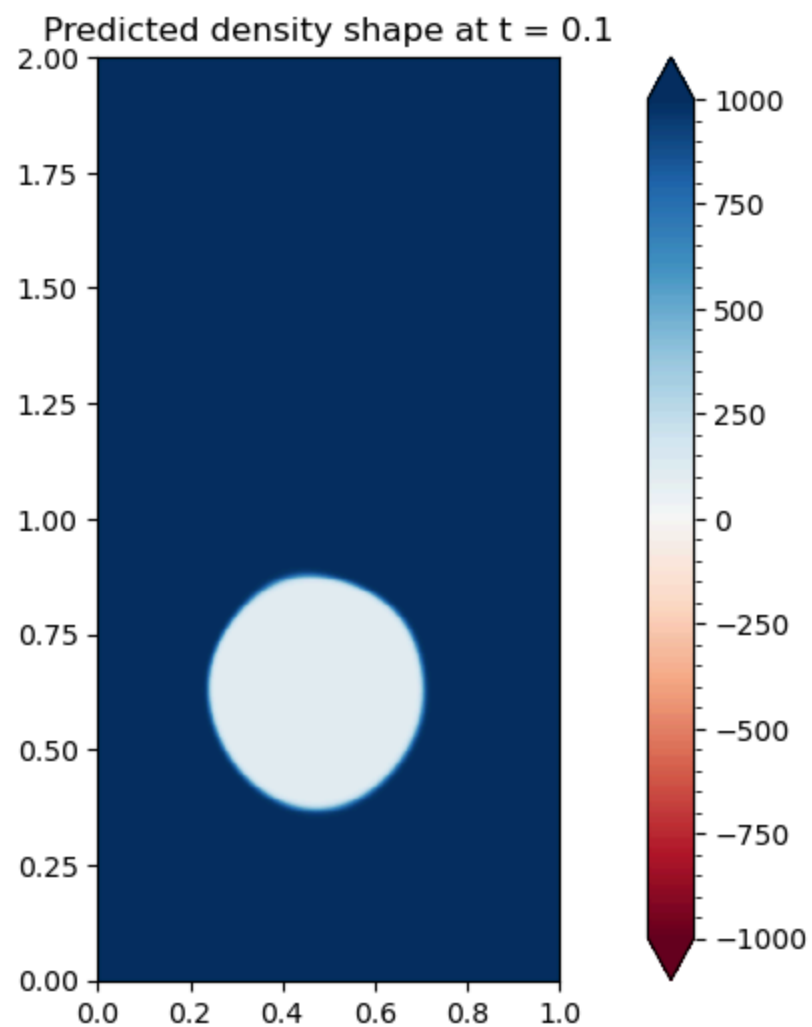
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cbar = fig.colorbar(pos_neg_clipped, ax=axes[1].invert_yaxis(), extend='both')
cbar.minorticks_on()

# Plot both positive and negative values between +/- 1000
pos_neg_clipped = axes[2].imshow(error.reshape(X.shape), cmap='RdBu', vmin=-1000, vmax=1000,
                                interpolation='none', extent = (net.x1_l, net.x1_u, net.x2_u, net.x2_l))
# Add minorticks on the colorbar to make it easy to read the
# values off the colorbar.
cbar = fig.colorbar(pos_neg_clipped, ax=axes[2].invert_yaxis(), extend='both')
cbar.minorticks_on()

plt.xticks(np.arange(0, 1, step=.1))
plt.yticks(np.arange(0, 2, step=.1))

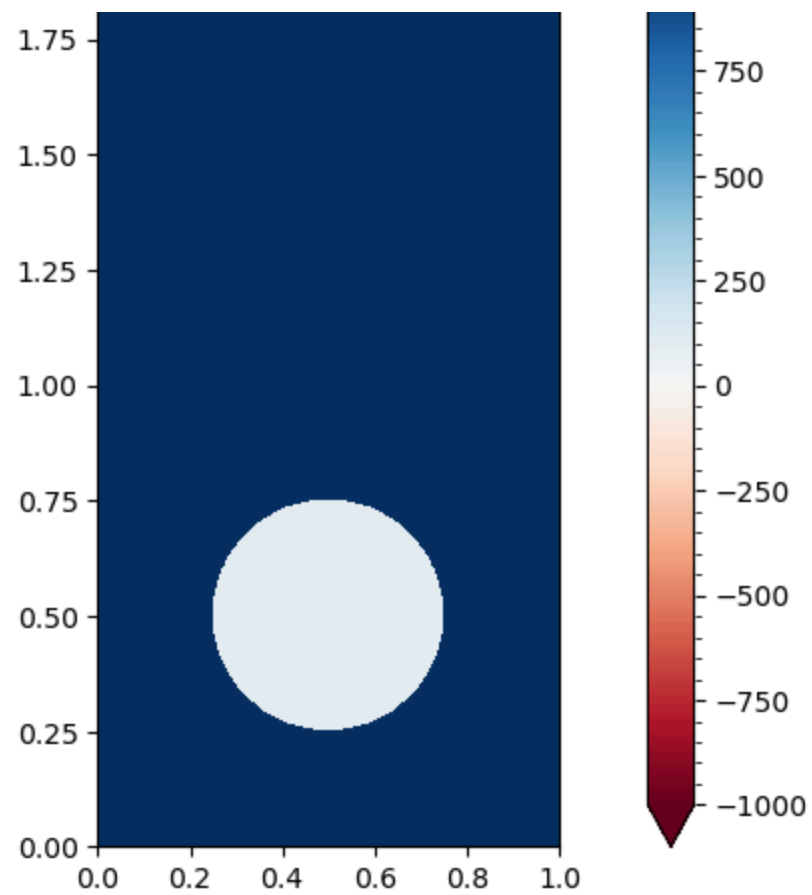
axes[2].legend()
fig.set_figheight(20)
fig.set_figwidth(10)

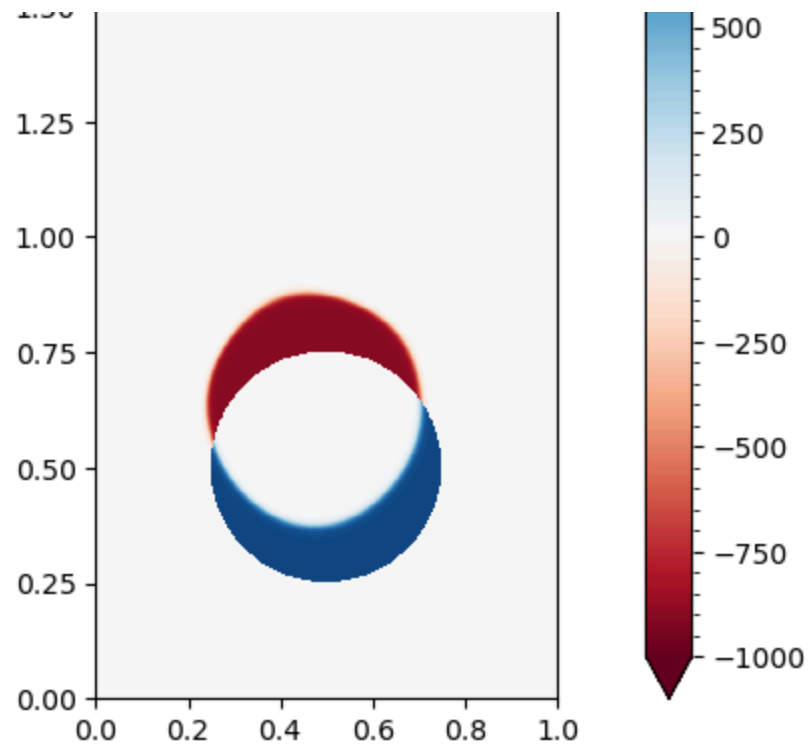
plt.show()
```



Actual Initial Density where $t=0$ for comparing movement







```
In [4]: import torch
from torch import nn
import numpy as np
from torch.autograd import Variable
import matplotlib.pyplot as plt

from Forward_with_Layer_Setting import Net
from InitialConditionLoss import InitialCondition_rho

#####

time_plotted = 0.2

#####

device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")

net = Net().to(device)
```

```

net.load_state_dict(torch.load("BubbleLayers_lr0.005_finaltime0.2.pt", map_location=torch.device('cpu')))

#Graph at various time slices

spatial_discretization = 1000

#Define numpy arrays for inputs
x1 = np.linspace(net.x1_l,net.x1_u,spatial_discretization).reshape(spatial_discretization)
x2 = np.linspace(net.x2_l,net.x2_u,spatial_discretization).reshape(spatial_discretization)
x1x2 = np.array(np.meshgrid(x1, x2)).reshape(2,spatial_discretization**2)

t = time_plotted*np.ones((spatial_discretization**2,1))

x1_input = x1x2[0].reshape(spatial_discretization**2, 1)
x2_input = x1x2[1].reshape(spatial_discretization**2, 1)

x1x2 = [x1_input, x2_input]

#convert to pytorch tensors
pt_x1 = Variable(torch.from_numpy(x1_input).float(), requires_grad=False).to(device)
pt_x2 = Variable(torch.from_numpy(x2_input).float(), requires_grad=False).to(device)
pt_t = Variable(torch.from_numpy(t).float(), requires_grad=False).to(device)

#get network outputs
pt_u1, pt_u2, pt_p, pt_rho = net(pt_x1, pt_x2, pt_t)

#get actual initial condition
rho_exact = InitialCondition_rho(net, pt_x1, pt_x2)

#Convert back to numpy
u1, u2, p, rho = pt_u1.data.cpu().numpy(), pt_u2.data.cpu().numpy(), pt_p.data.cpu().numpy(), pt_rho.data.cpu().numpy()
rho_exact = rho_exact.data.cpu().numpy()
error = rho-rho_exact

X, Y = np.meshgrid(x1, x2)

fig, axs = plt.subplots(3 )
#fig.suptitle(f'Time = {time_plotted}')

```

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fig.tight_layout()
axs[0].set_title("Predicted density shape at t = %.1f" % time_plotted)
axs[1].set_title('Actual Initial Density where t=0 for comparing movement')
axs[2].set_title('Error')
#axs[0].pcolor(X, Y, rho.reshape(X.shape))
#axs[1].pcolor(X, Y, rho_exact.reshape(X.shape))
#axs[2].pcolor(X, Y, error.reshape(X.shape))

# Plot both positive and negative values between +/- 1.2
pos_neg_clipped = axs[0].imshow(rho.reshape(X.shape), cmap='RdBu', vmin=-1000, vmax=1000,
                                interpolation='none', extent = (net.x1_l,net.x1_u, net.x2_u, net.x2_l))
# Add minorticks on the colorbar to make it easy to read the
# values off the colorbar.
cbar = fig.colorbar(pos_neg_clipped, ax=axs[0].invert_yaxis(), extend='both')
cbar.minorticks_on()

# Plot both positive and negative values between +/- 1.2
pos_neg_clipped = axs[1].imshow(rho_exact.reshape(X.shape), cmap='RdBu', vmin=-1000, vmax=1000,
                                interpolation='none', extent = (net.x1_l,net.x1_u, net.x2_u, net.x2_l))
# Add minorticks on the colorbar to make it easy to read the
# values off the colorbar.
cbar = fig.colorbar(pos_neg_clipped, ax=axs[1].invert_yaxis(), extend='both')
cbar.minorticks_on()

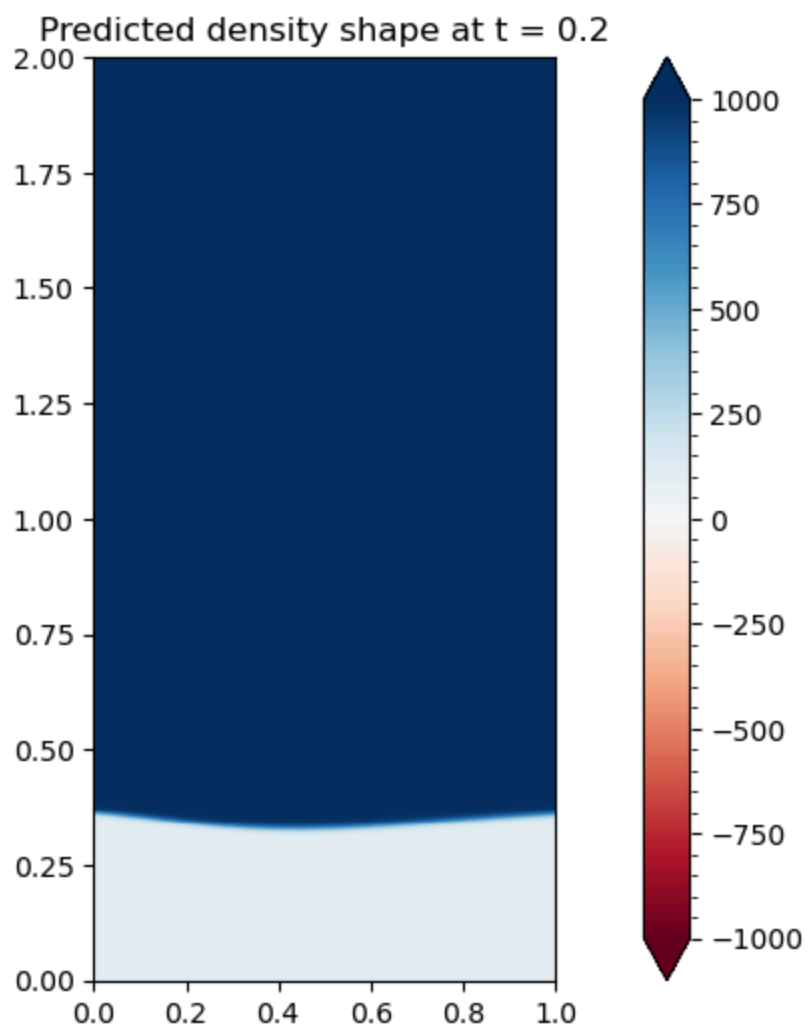
# Plot both positive and negative values between +/- 1000
pos_neg_clipped = axs[2].imshow(error.reshape(X.shape), cmap='RdBu', vmin=-1000, vmax=1000,
                                interpolation='none', extent = (net.x1_l,net.x1_u, net.x2_u, net.x2_l))
# Add minorticks on the colorbar to make it easy to read the
# values off the colorbar.
cbar = fig.colorbar(pos_neg_clipped, ax=axs[2].invert_yaxis(), extend='both')
cbar.minorticks_on()

#plt.xticks(np.arange(0, 1, step=.1))
#plt.yticks(np.arange(0, 2, step=.1))

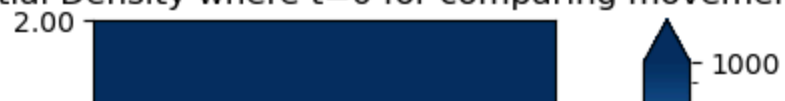
#axs[2].legend()
fig.set_figheight(20)
fig.set_figwidth(10)

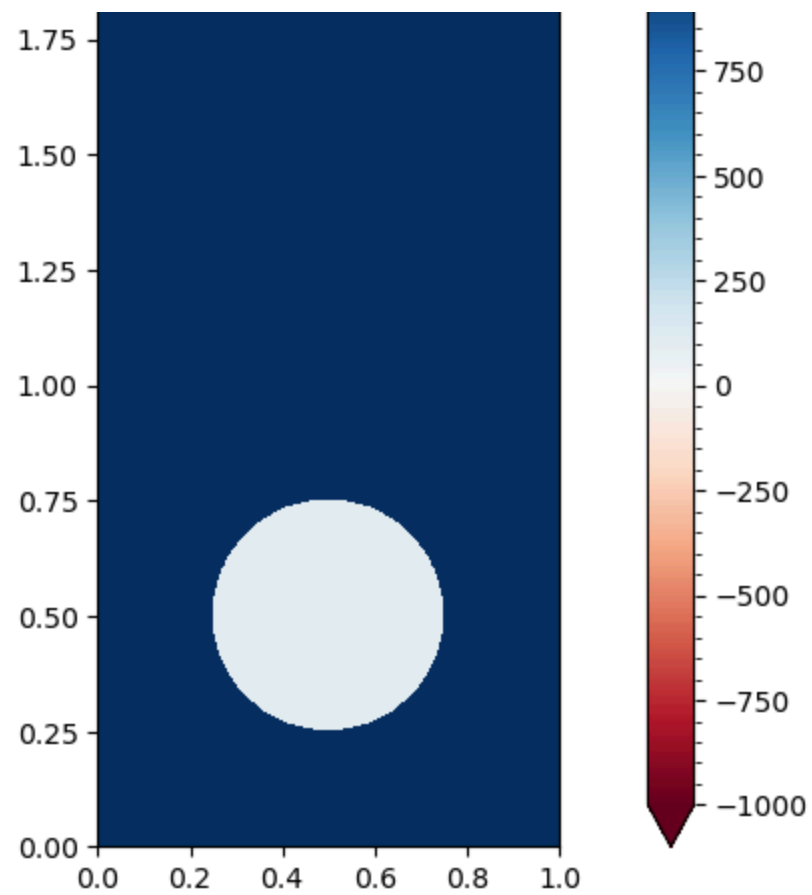
plt.show()

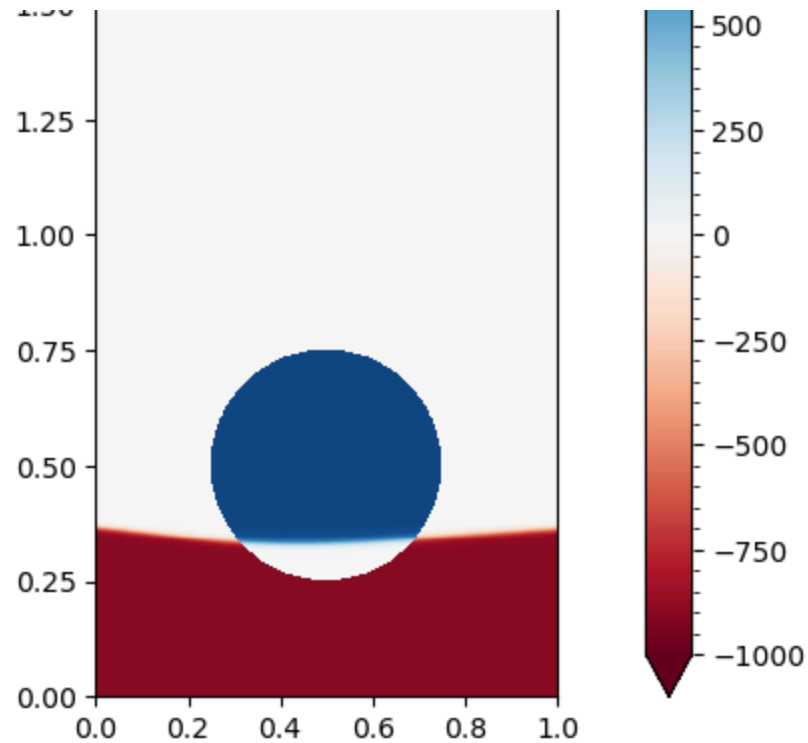
```

Actual Initial Density where $t=0$ for comparing movement







```
In [1]: import torch
        from torch import nn
        import numpy as np
        from torch.autograd import Variable
        import matplotlib.pyplot as plt

        from Forward_with_Layer_Setting import Net
        from InitialConditionLoss import InitialCondition_rho

        #####

        time_plotted = 0.4

        #####

        device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")

        net = Net().to(device)
```

```

net.load_state_dict(torch.load("BubbleLayers_lr0.005_finaltime0.4.pt", map_location=torch.device('cpu')))

#Graph at various time slices

spatial_discretization = 1000

#Define numpy arrays for inputs
x1 = np.linspace(net.x1_l,net.x1_u,spatial_discretization).reshape(spatial_discretization)
x2 = np.linspace(net.x2_l,net.x2_u,spatial_discretization).reshape(spatial_discretization)
x1x2 = np.array(np.meshgrid(x1, x2)).reshape(2,spatial_discretization**2)

t = time_plotted*np.ones((spatial_discretization**2,1))

x1_input = x1x2[0].reshape(spatial_discretization**2, 1)
x2_input = x1x2[1].reshape(spatial_discretization**2, 1)

x1x2 = [x1_input, x2_input]

#convert to pytorch tensors
pt_x1 = Variable(torch.from_numpy(x1_input).float(), requires_grad=False).to(device)
pt_x2 = Variable(torch.from_numpy(x2_input).float(), requires_grad=False).to(device)
pt_t = Variable(torch.from_numpy(t).float(), requires_grad=False).to(device)

#get network outputs
pt_u1, pt_u2, pt_p, pt_rho = net(pt_x1, pt_x2, pt_t)

#get actual initial condition
rho_exact = InitialCondition_rho(net, pt_x1, pt_x2)

#Convert back to numpy
u1, u2, p, rho = pt_u1.data.cpu().numpy(), pt_u2.data.cpu().numpy(), pt_p.data.cpu().numpy(), pt_rho.data.cpu().numpy()
rho_exact = rho_exact.data.cpu().numpy()
error = rho-rho_exact

X, Y = np.meshgrid(x1, x2)

fig, axs = plt.subplots(3 )
#fig.suptitle(f'Time = {time_plotted}')

```

```

fig.tight_layout()
axs[0].set_title("Predicted density shape at t = %.1f" % time_plotted)
axs[1].set_title('Actual Initial Density where t=0 for comparing movement')
axs[2].set_title('Error')
#axs[0].pcolor(X, Y, rho.reshape(X.shape))
#axs[1].pcolor(X, Y, rho_exact.reshape(X.shape))
#axs[2].pcolor(X, Y, error.reshape(X.shape))

# Plot both positive and negative values between +/- 1.2
pos_neg_clipped = axs[0].imshow(rho.reshape(X.shape), cmap='RdBu', vmin=-1000, vmax=1000,
                                interpolation='none', extent = (net.x1_l,net.x1_u, net.x2_u, net.x2_l))
# Add minorticks on the colorbar to make it easy to read the
# values off the colorbar.
cbar = fig.colorbar(pos_neg_clipped, ax=axs[0].invert_yaxis(), extend='both')
cbar.minorticks_on()

# Plot both positive and negative values between +/- 1.2
pos_neg_clipped = axs[1].imshow(rho_exact.reshape(X.shape), cmap='RdBu', vmin=-1000, vmax=1000,
                                interpolation='none', extent = (net.x1_l,net.x1_u, net.x2_u, net.x2_l))
# Add minorticks on the colorbar to make it easy to read the
# values off the colorbar.
cbar = fig.colorbar(pos_neg_clipped, ax=axs[1].invert_yaxis(), extend='both')
cbar.minorticks_on()

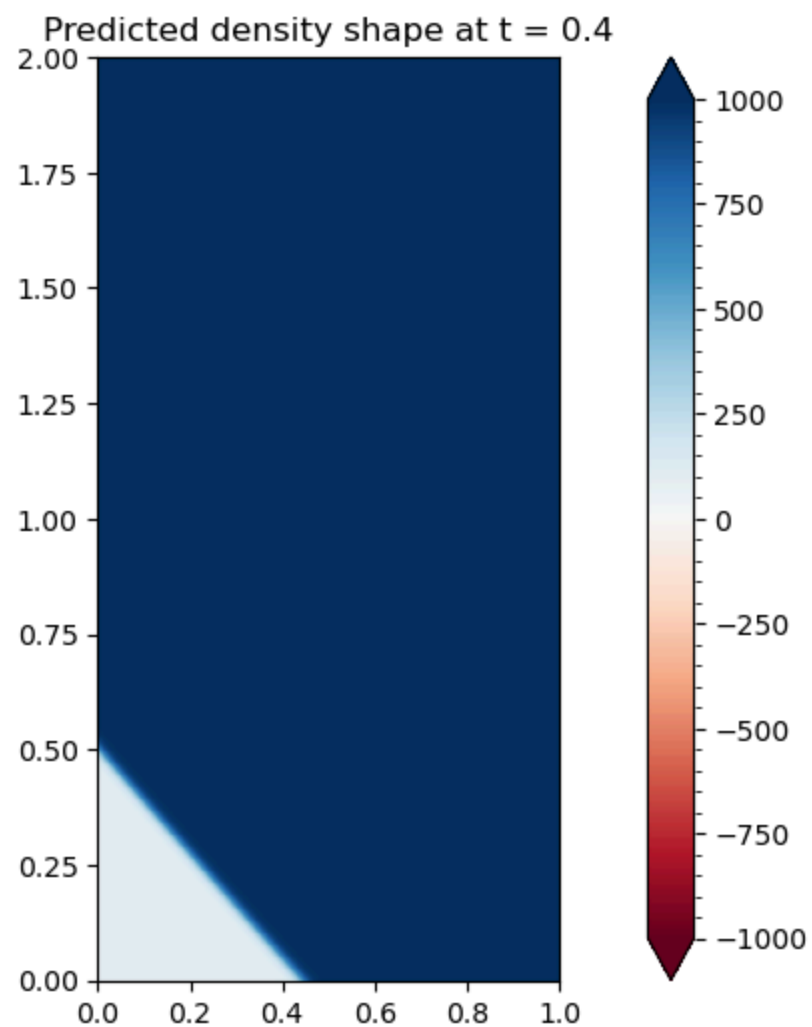
# Plot both positive and negative values between +/- 1000
pos_neg_clipped = axs[2].imshow(error.reshape(X.shape), cmap='RdBu', vmin=-1000, vmax=1000,
                                interpolation='none', extent = (net.x1_l,net.x1_u, net.x2_u, net.x2_l))
# Add minorticks on the colorbar to make it easy to read the
# values off the colorbar.
cbar = fig.colorbar(pos_neg_clipped, ax=axs[2].invert_yaxis(), extend='both')
cbar.minorticks_on()

#plt.xticks(np.arange(0, 1, step=.1))
#plt.yticks(np.arange(0, 2, step=.1))

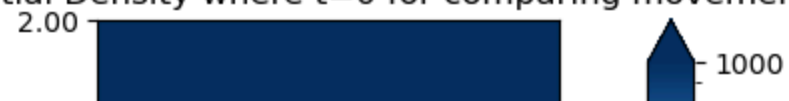
#axs[2].legend()
fig.set_figheight(20)
fig.set_figwidth(10)

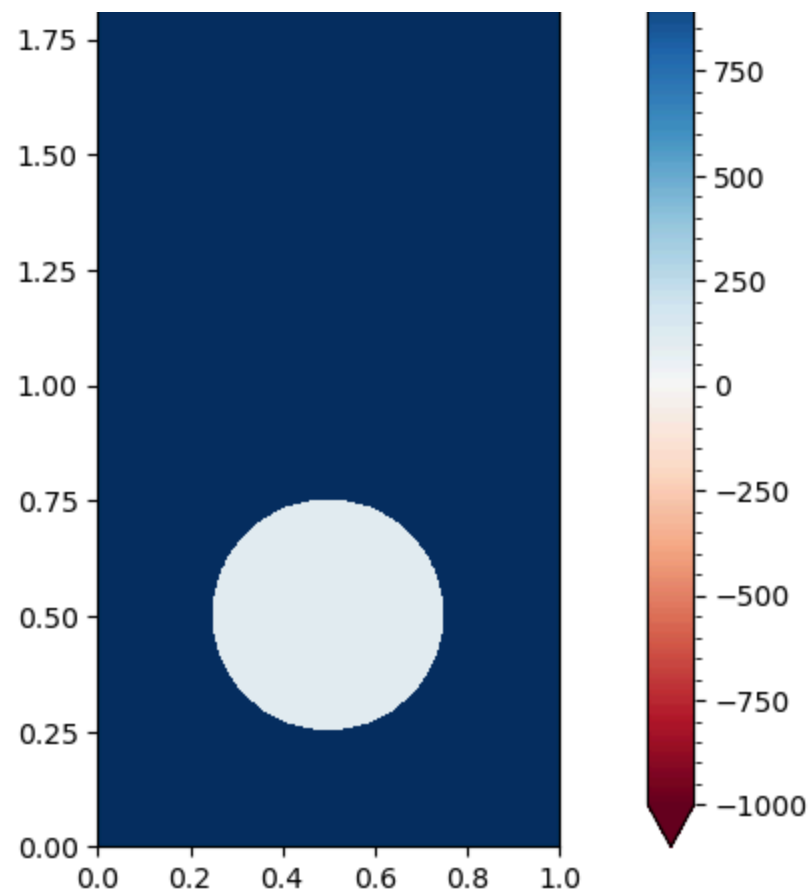
plt.show()

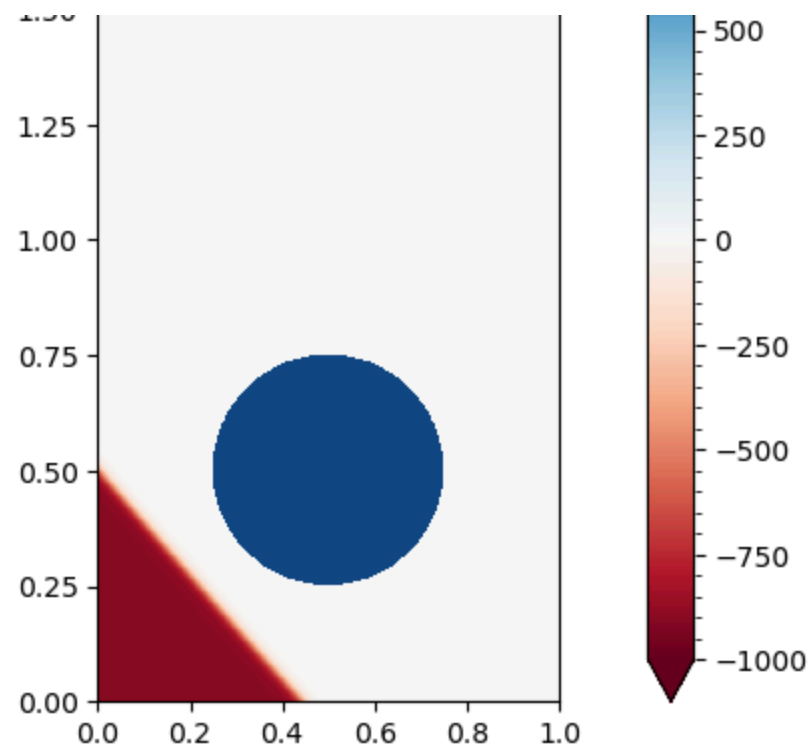
```



Actual Initial Density where $t=0$ for comparing movement







In []: