Meridional plots in Kerr spacetime for /m=0.99$

Return to the past !

Thanks to Eric and Team from whom I used most of ressources, with a little question ?

Has yin and yang to do with black holes ?

In [1]:
```
%display latex
```

O'Neill exponential coordinates:

In [2]:
```
x,y = var('x y')
r = 1/2*ln(x^2 + y^2)
costh2 = y^2/(x^2+y^2)
sinth2 = x^2/(x^2+y^2)
```

Function f defining the ergoregion by $f < 0$:

In [3]:
```
a = 0.99
f = r^2 -2*r + a^2*costh2
f
```

Out[3]:

$$\frac{1}{4}\log\left(x^2+y^2\right)^2+\frac{0.980100000000000\,y^2}{x^2+y^2}-\log\left(x^2+y^2\right)$$

In [4]:
```
ergo = region_plot(f < 0, (x,-8, 8), (y, -5, 5),
incol='lightgray',bordercol='grey',
axes_labels=[r'$\mathrm{e}^{r/m}\sin\theta$',
r'$\mathrm{e}^{r/m}\cos\theta$'])
ergo += text(r'$\mathscr{E}^+$', (1.05*e^2, 0.5*e),
color='grey',fontsize=20)
ergo += text(r'$\mathscr{E}^-$', (1.5, 0.8),
color='grey',fontsize=20)
```

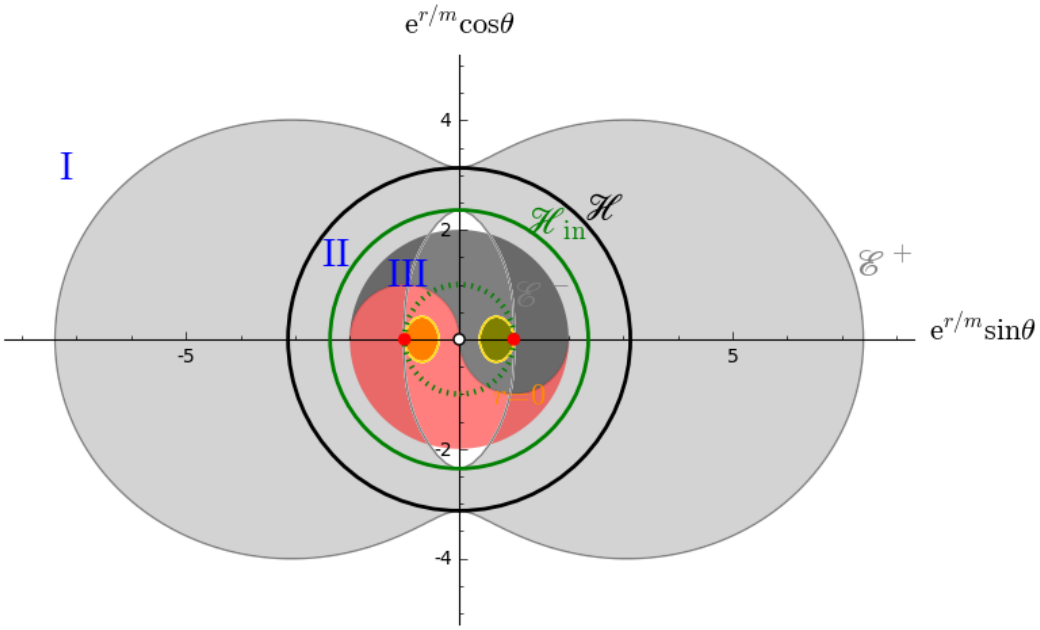
Various remarkable surfaces:

In [5]:
```
Rp = exp(1 + sqrt(1-a^2))
Rm = exp(1 - sqrt(1-a^2))
Hp = circle((0,0), Rp, color='black',
thickness=2) + text(r'$\mathscr{H}$',
(0.84*Rp, 0.77*Rp), color='black', fontsize=20)
Hm = circle((0,0), Rm, color='green',
thickness=2) +text(r'$\mathscr{H}_{\rm in}$',
(0.75*Rm, 0.9*Rm), color='green', fontsize=20)
R0 = circle((0,0), 1, color='green',
linestyle='dotted', thickness=3) + text(r'$r\!=\!0$',
(1.1,-1.), color='darkorange', fontsize=16)
sing = circle((1,0), 0.1, color='red',
fill=True) + circle((-1,0), 0.1, color='red',
fill=True)
rminf = circle((0,0), 0.1, edgecolor='black', facecolor='white', fill=True)
region_label = text(r'${\rm I}$', (-2.3*Rp, Rp), fontsize=20) + \
               text(r'${\rm II}$', (-0.72*Rp, 0.5*Rp), fontsize=20) + \
               text(r'${\rm III}$', (-0.4*Rm, 0.5*Rm), fontsize=20)
graph = ergo + Hp + Hm + R0 + sing + rminf + region_label
```

Carter time machine:

In [6]:
```
ft = (r^2+a^2)*(r^2+a^2*costh2) + 2*a^2*r*sinth2
```

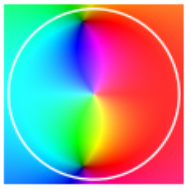
In [7]:
```
var("y");r=2/sqrt(n(pi))
def f(x):
    if x<0:
        return sqrt(-x^2-2*x)
    else:
        return -sqrt(-x^2+2*x)
ci = circle((0,0),r,color="green",
fill=True,zorder=-5,thickness=2,alpha=1)
a=plot(f,(x,-2,2),color='black',fill=sqrt(4-x^2),
fillcolor="black",alpha=0.1)
b=plot(f,(x,-2,2),color="red",fill=-sqrt(4-x^2),
fillcolor="red",alpha=0.1)
tmachine = region_plot(ft < 0, (x,-2, 2),
(y, -2, 2), incol='yellow', bordercol='gold')
graph += tmachine
show(a+b+graph, aspect_ratio=1)
```



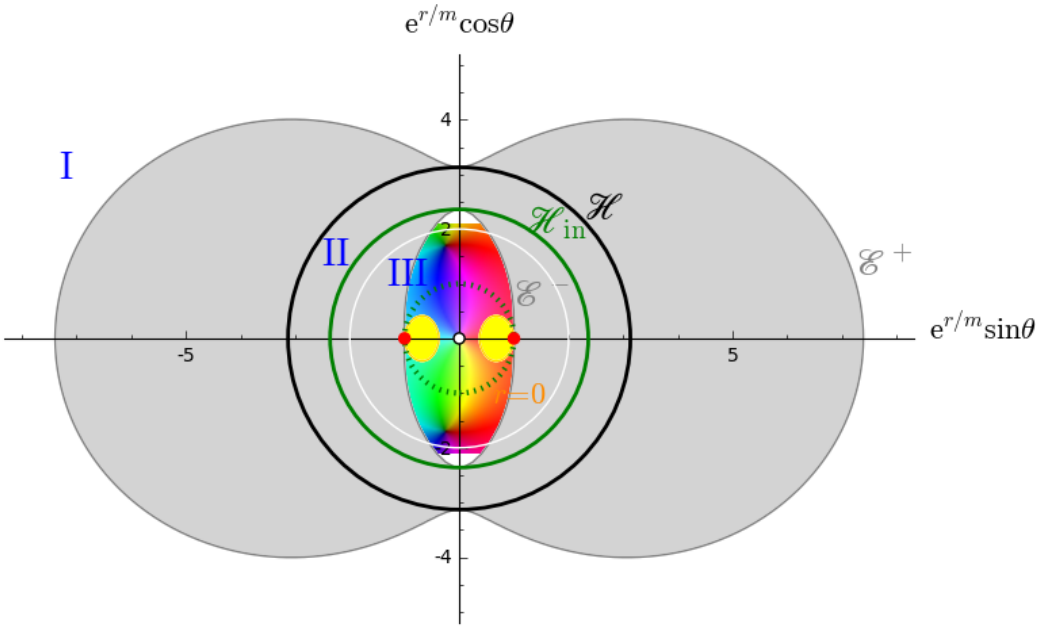
In [8]:
```
#graph.save("ker_ergo_a99.pdf", aspect_ratio=1)
```

In [9]:
```
f(z) = z^1+ z + 1 + 6/z
cp=complex_plot(f, (-2.1, 2.1), (-2.1, 2.1))
```

In [10]:
```
ci=circle((0,0),2,color="white")
show(cp+ci,figsize=2,fontsize=3,
     axes=False,frame=False,aspect_ratio=1)
```



In [11]:
```
show(graph+ci+cp, aspect_ratio=1)
```



In [ ]:
```

```