In [1]:

```
from sympy import Symbol, sin, cos, sqrt, pi
from sympy.plotting.plot import plot_parametric as plotp
```

In [2]:

```
theta = Symbol('theta')
```

In [3]:

```
def r_erg_m(M, a, theta):
    return M - sqrt((M ** 2) - ((a ** 2) * (cos(theta) ** 2)))
```

In [4]:

```
def r_erg_p(M, a, theta):
    return M + sqrt((M ** 2) - ((a ** 2) * (cos(theta) ** 2)))
```

In [5]:

```
def r_hor_m(M, a):
    return M - sqrt((M ** 2) - (a ** 2))
```

In [6]:

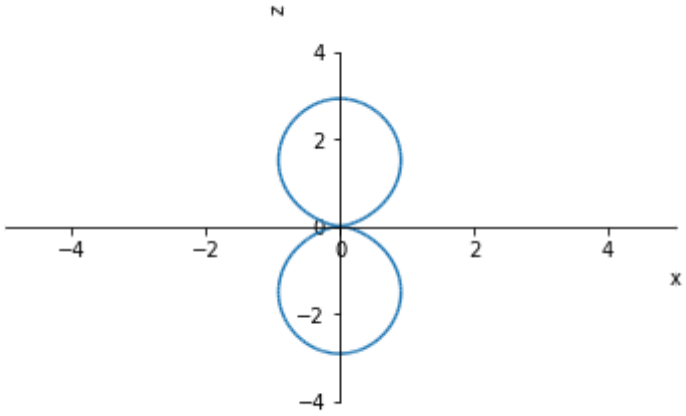
```
def r_hor_p(M, a):
    return M + sqrt((M ** 2) - (a ** 2))
```

In [7]:

```
m = 4.2
a = 4.0
```

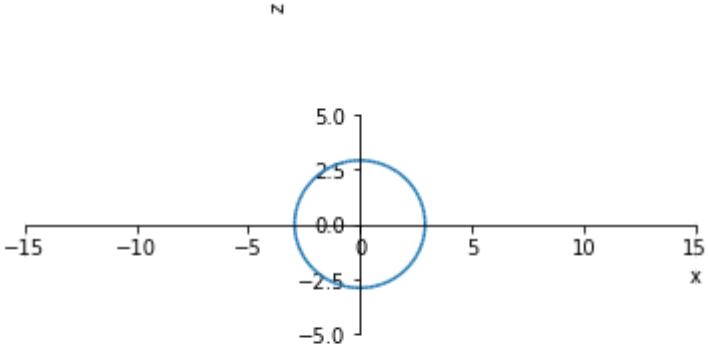
In [14]:

```
inner_ergosurface = plotp(
    (
        r_erg_m(m, a, theta) * sin(theta),
        r_erg_m(m, a, theta) * cos(theta)
    ),
    (theta, 0, 2 * pi), aspect_ratio=(1,1),
    xlim=[-5, 5], ylim=[-5, 5],
    xlabel="x", ylabel="z"
)
```



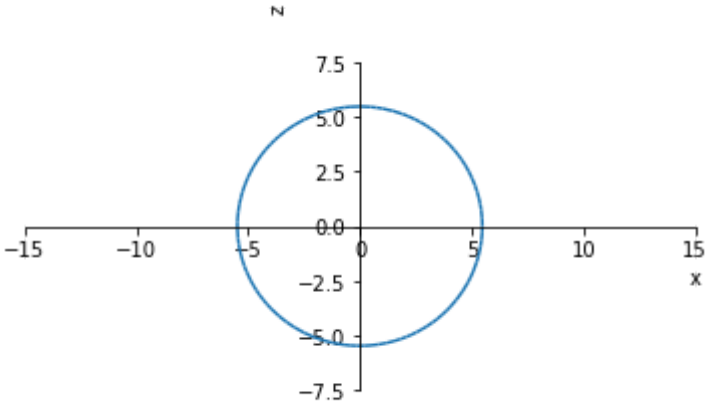
In [9]:

```
inner_event_horizon = plotp(
    (
        r_hor_m(m, a) * sin(theta),
        r_hor_m(m, a) * cos(theta)
    ),
    (theta, 0, 2 * pi), aspect_ratio=(1,1),
    xlim=[-15, 15], ylim=[-10, 10],
    xlabel="x", ylabel="z"
    )
```



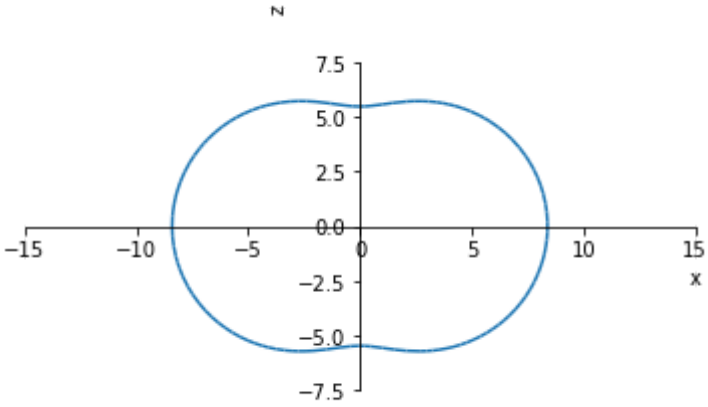
In [10]:

```
outer_event_horizon = plotp(
    (
        r_hor_p(m, a) * sin(theta),
        r_hor_p(m, a) * cos(theta)
    ),
    (theta, 0, 2 * pi), aspect_ratio=(1,1),
    xlim=[-15, 15], ylim=[-10, 10],
    xlabel="x", ylabel="z"
    )
```



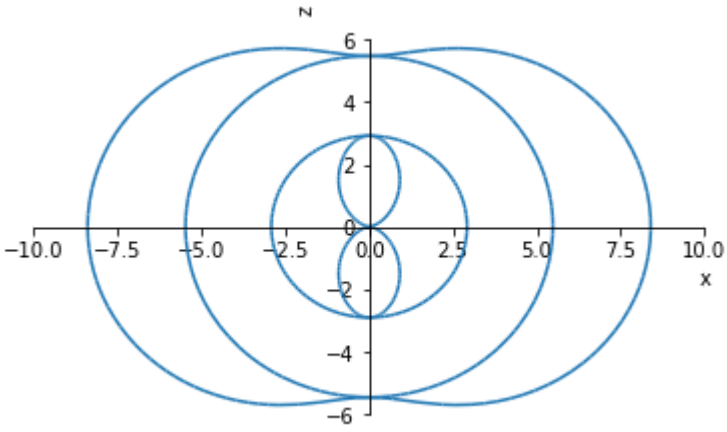
In [11]:

```
outer_ergosurface = plotp(
    (
        r_erg_p(m, a, theta) * sin(theta),
        r_erg_p(m, a, theta) * cos(theta)
    ),
    (theta, 0, 2 * pi),
    xlim=[-15, 15], ylim=[-10, 10], aspect_ratio=(1,1),
    xlabel="x", ylabel="z"
    )
```



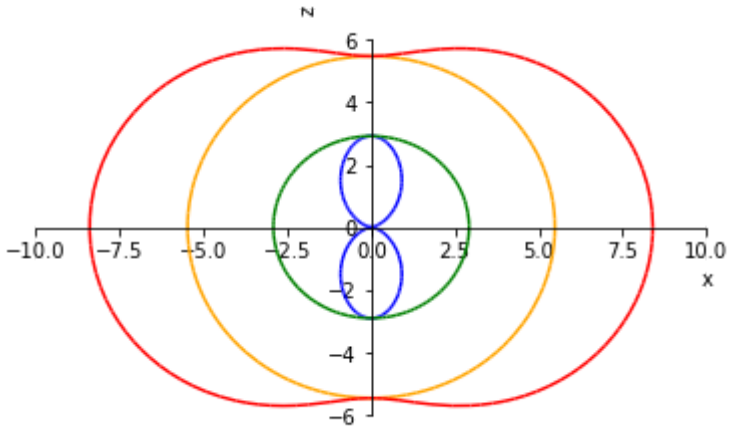
In [12]:

```
black_hole = plotp(
    (
        r_erg_m(m, a, theta) * sin(theta),
        r_erg_m(m, a, theta) * cos(theta)
    ),
    (
        r_hor_m(m, a) * sin(theta),
        r_hor_m(m, a) * cos(theta)
    ),
    (
        r_hor_p(m, a) * sin(theta),
        r_hor_p(m, a) * cos(theta)
    ),
    (
        r_erg_p(m, a, theta) * sin(theta),
        r_erg_p(m, a, theta) * cos(theta)
    ),
    (theta, 0, 2 * pi), aspect_ratio=(1,1),
    xlim=[-10, 10], ylim=[-7.0, 7.0],
    xlabel="x", ylabel="z"
)
```



In [13]:

```
black_hole[0].line_color = 'blue'
black_hole[1].line_color = 'green'
black_hole[2].line_color = 'orange'
black_hole[3].line_color = 'red'
black_hole.show()
```



In [ ]:

```

```