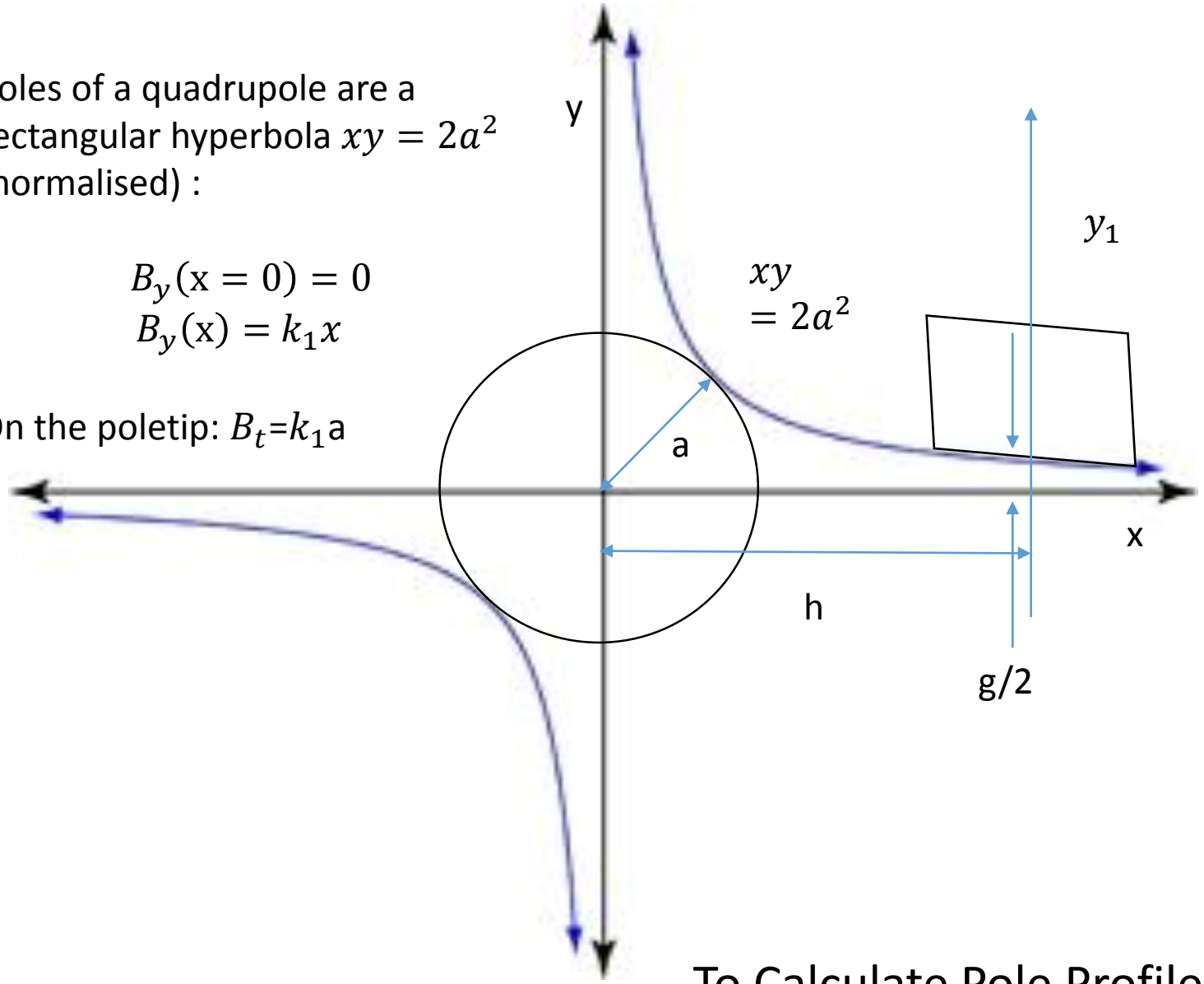
Poles of a quadrupole are a rectangular hyperbola $xy = 2a^2$ (normalised) :

$$B_y(\mathrm{x} = 0) = 0$$
$$B_y(\mathrm{x}) = k_1 x$$

On the poletip: B_t=k_1a



Combined function nagnet is like a quadrupole shifted by distance, h

In new coords (x, y_1) the poles have equation (x+h) $y_1 = 2a^2$

B_1=$k_1 h$, B_z'=k_1 (normalised)

$h = B_1/B_z'$, $h\frac{g}{2} = 2a^2$

Given B_0 and B_z' for CF magnet solve above equns to find:

h and a

Then profile is $y_1 = 2a^2/(x+h)$

To Calculate Pole Profile of CF Magnet

```
BEAM, PARTICLE=ELECTRON,PC=3.0;
DEGREE:=PI/180.0;
QF: QUADRUPOLE,L=0.5,K1=0.2;
QD: QUADRUPOLE,L=1.0,K1=-0.2;
B: SBEND,L=1.0,ANGLE=15.0*DEGREE;
```

$(B\rho) = 10^9/c*PC = 10\text{^}9/299792485*3.0 = 10.01$ Tm

dipole (SBEND)

$B = |ANGLE|/L*(B\rho) = (15*pi/180)/1.0*10.01 = 2.62$ T

quadrupole

$G = |K1|*(B\rho) = 0.2*10.01 = 2.00$ T/m

Definition of field error coefficients

$$B_{y,id}(x) = B_1$$

$$B_y(x) = B_1 + \frac{B_1}{10000}\left[b_2\left(\frac{x}{R}\right) + b_3\left(\frac{x}{R}\right)^2 + b_4\left(\frac{x}{R}\right)^3 + \cdots\right]$$

$$\frac{\Delta B}{B}(x) = \frac{1}{10000}\left[b_2\left(\frac{x}{R}\right) + b_3\left(\frac{x}{R}\right)^2 + b_4\left(\frac{x}{R}\right)^3 + \cdots\right]$$