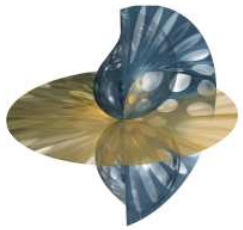
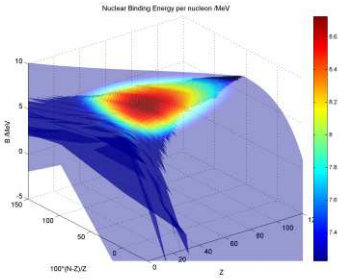


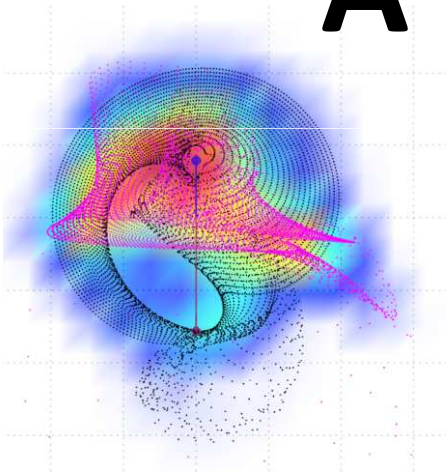




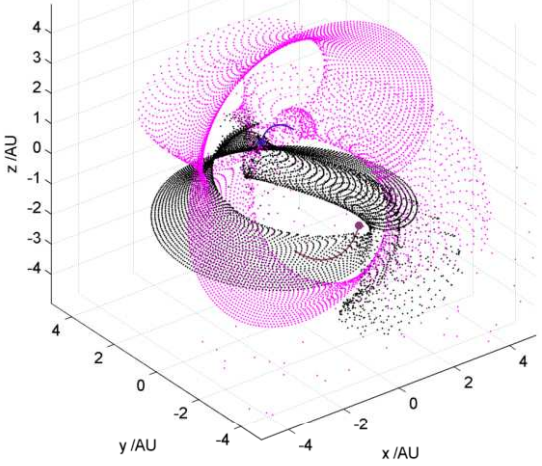
A mathematical mezze

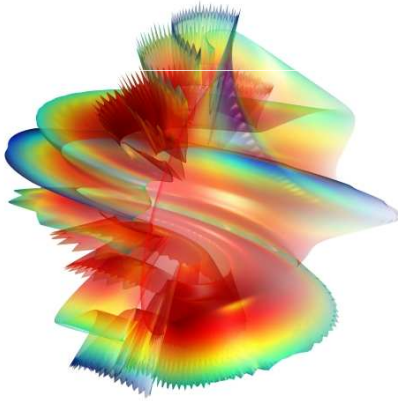
AF 2012-2013

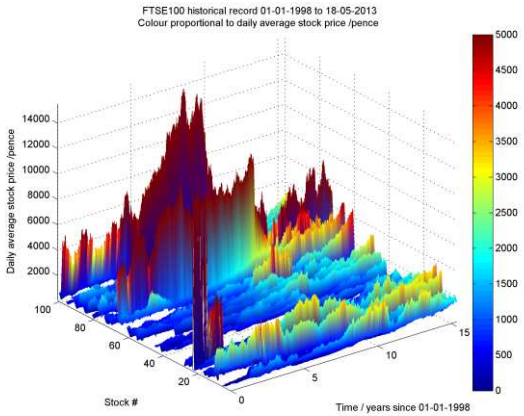


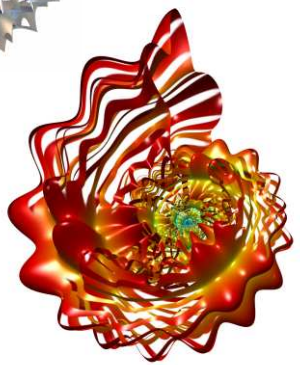
progsoc

Thursdays. 1600-1745.
Science School computer room.



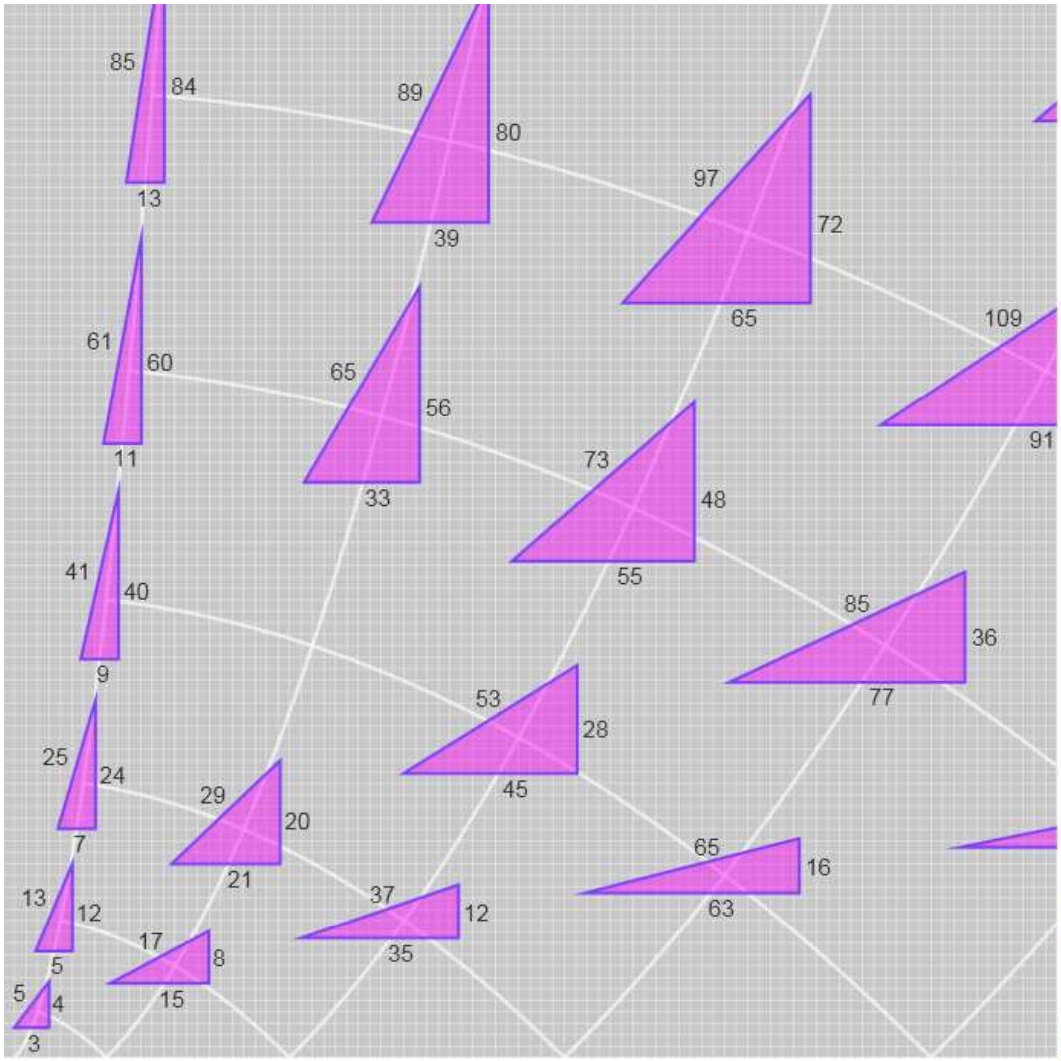


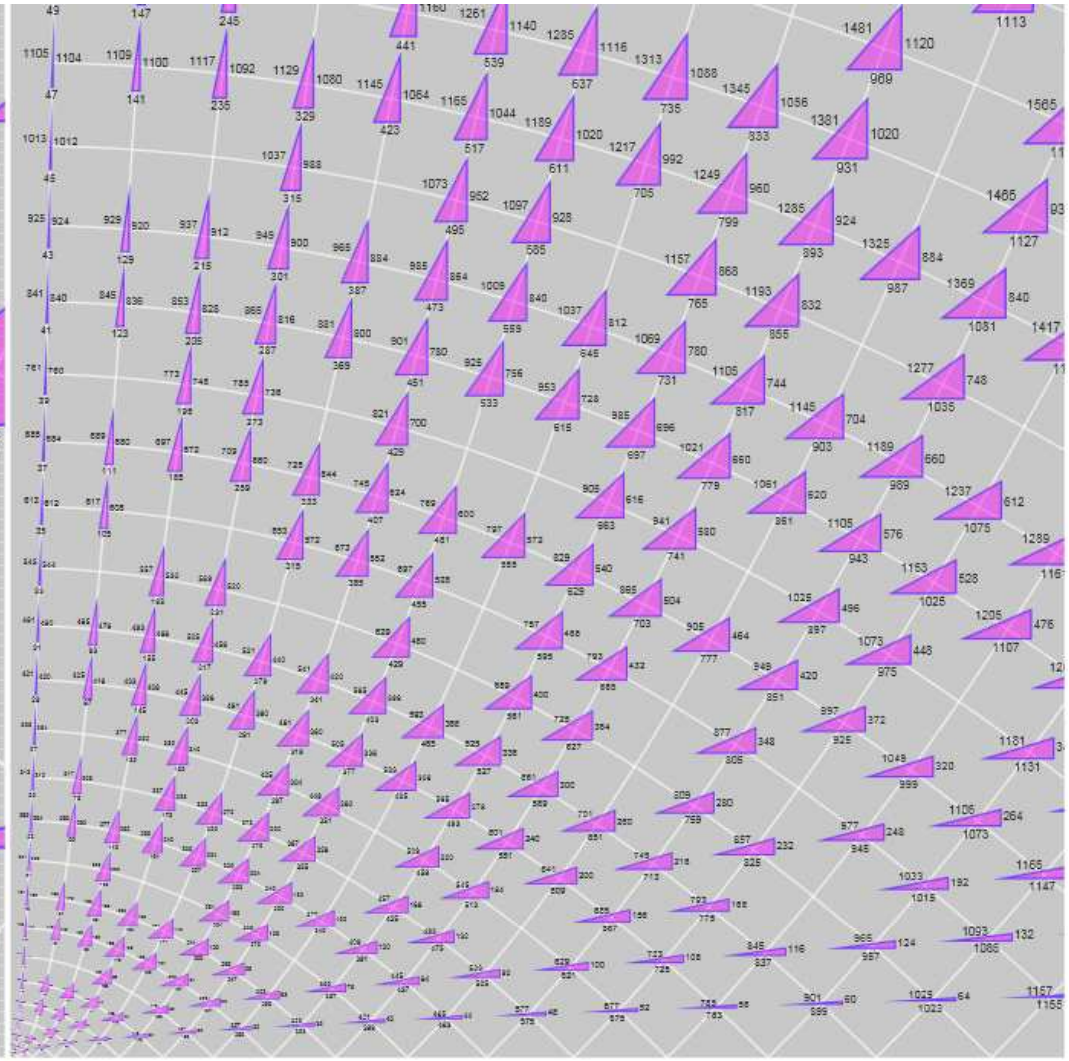




μathematicon

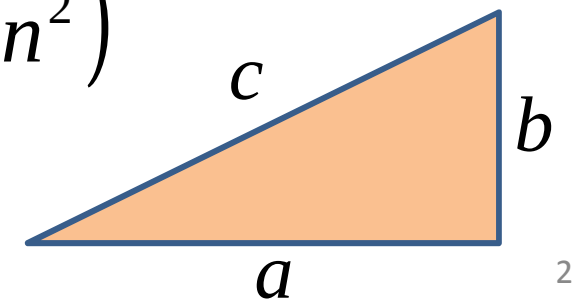
1. Pythagorean triples



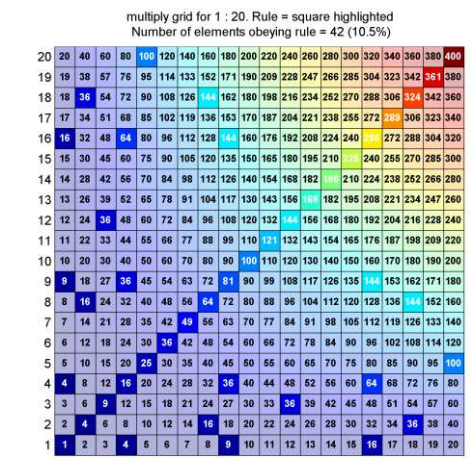


$$a = k\left(m^2 - n^2\right) \qquad b = 2kmn \qquad c = k\left(m^2 + n^2\right)$$

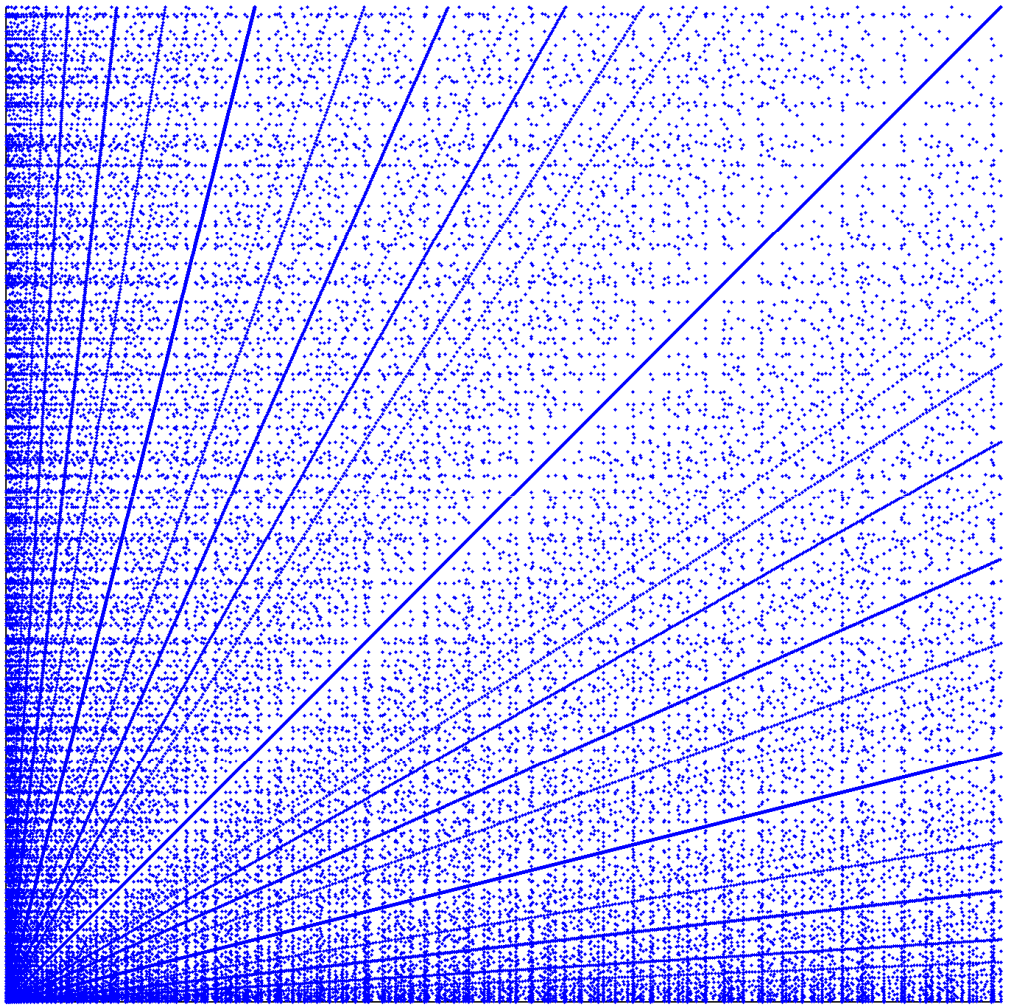
$$c^2 = a^2 + b^2$$



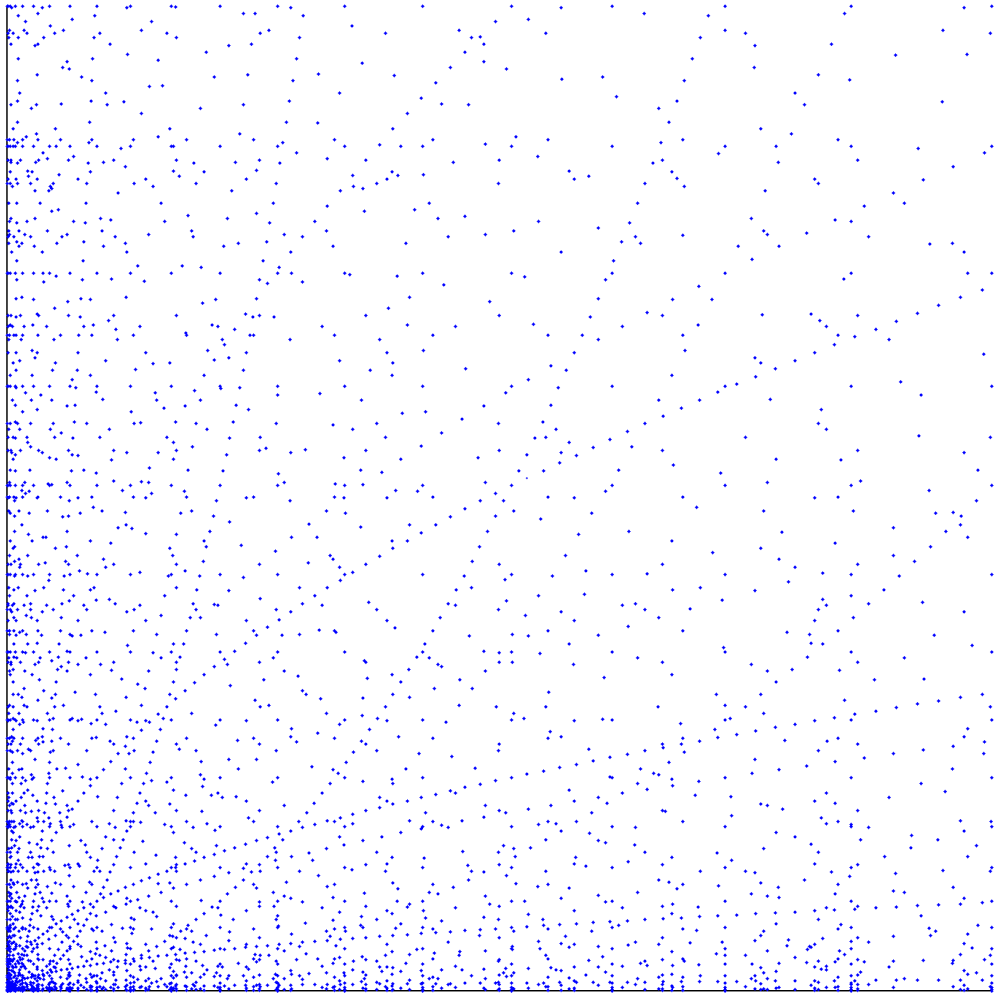
2. Squares and Cubes



multiply grid for 1 : 8000. Rule = square highlighted
Number of elements obeying rule = 44872 (0.070112%)

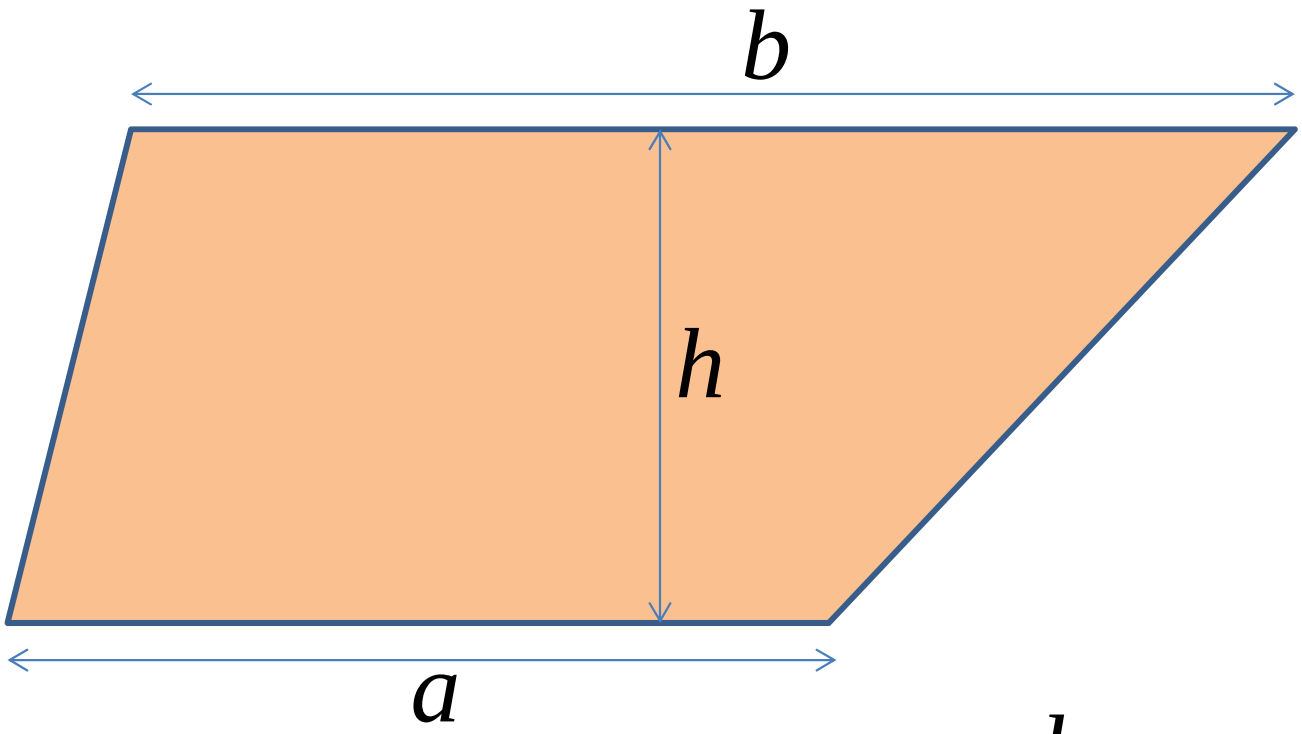


multiply grid for 1 : 8000. Rule = cube highlighted
Number of elements obeying rule = 3154 (0.0049281%)



3. Area of a trapezium

$$A = \frac{1}{2}(a+b)h$$



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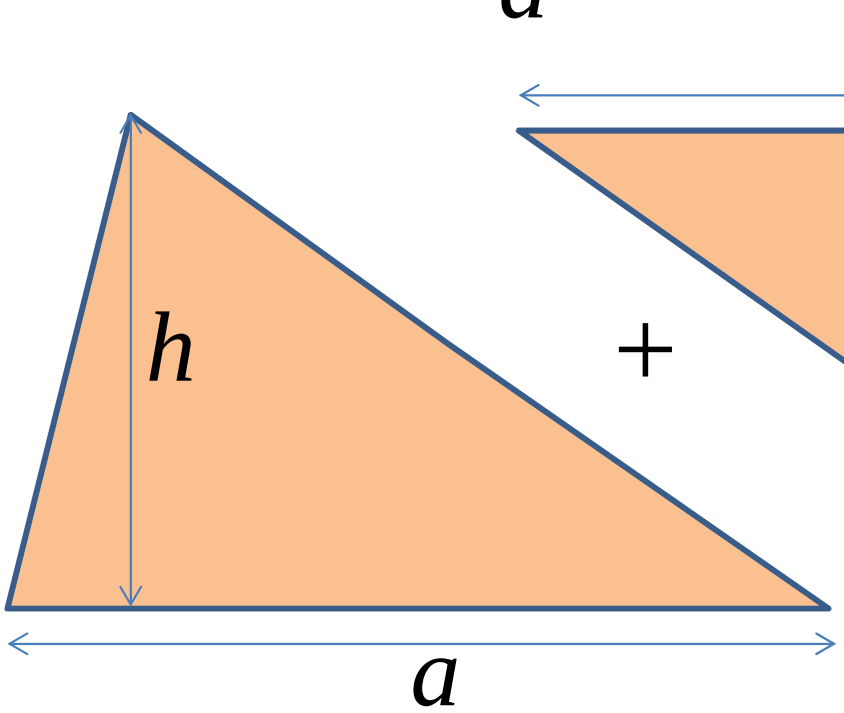

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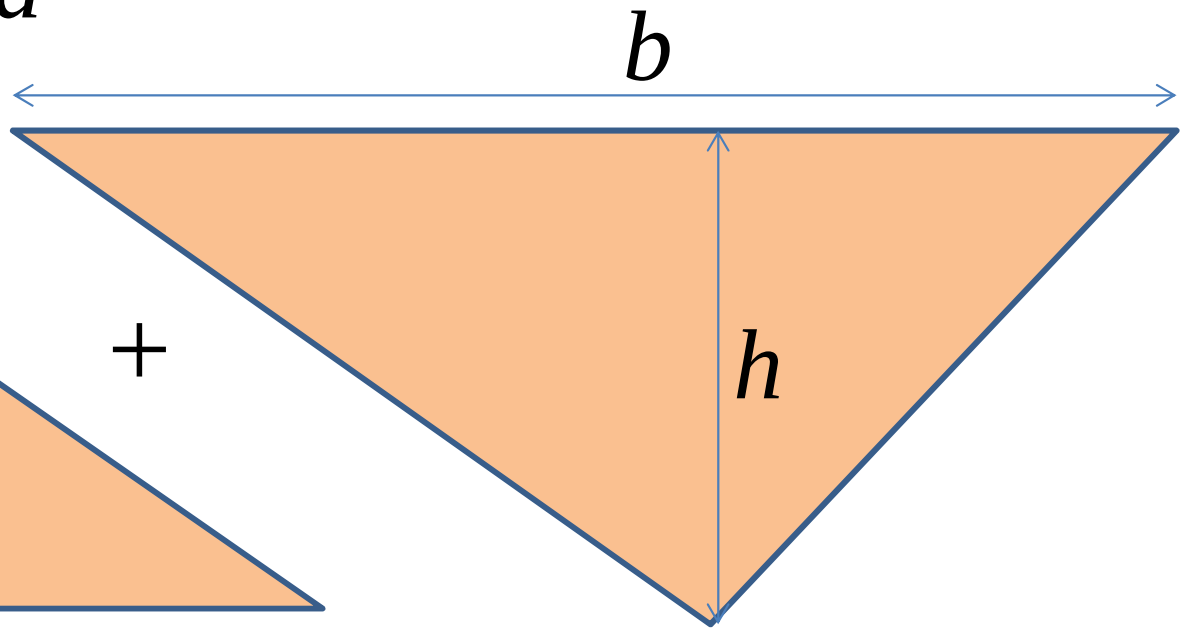
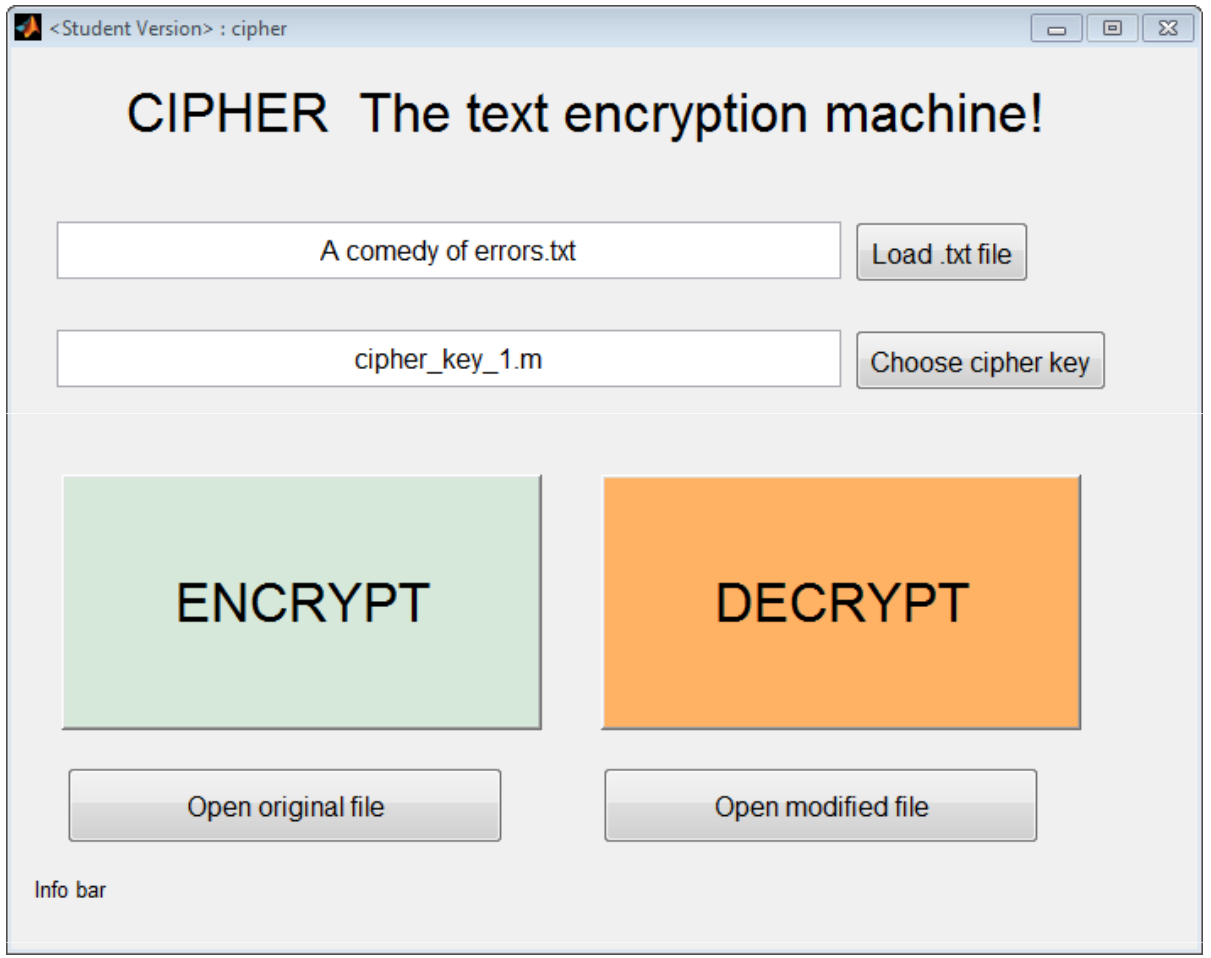


4. Cipher

The Comedy of Errors by William Shakespeare

ACT I
SCENE I. A hall in DUKE SOLINUS'S palace.

Enter DUKE SOLINUS, AEGEON, Gaoler, Officers, and other Attendants
AEGEON
Proceed, Solinus, to procure my fall
And by the doom of death end woes and all.



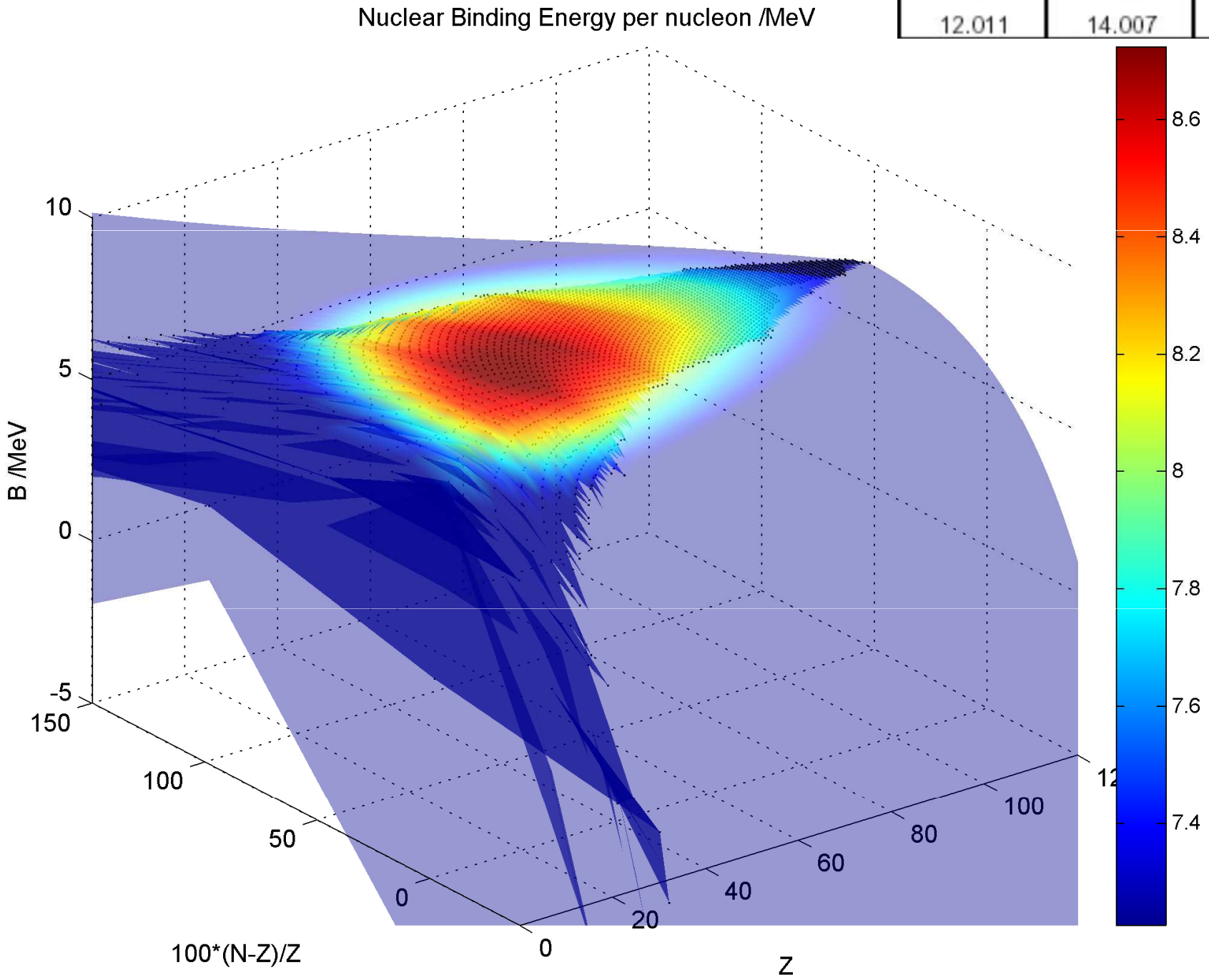
Uif Dpnfez pg Fsspst cz Xjmmjbn Tiblftqfbsf

BDU J
TDFOF J£ B ibmm jo EVLF TPMJOVT'T qbmbdf£

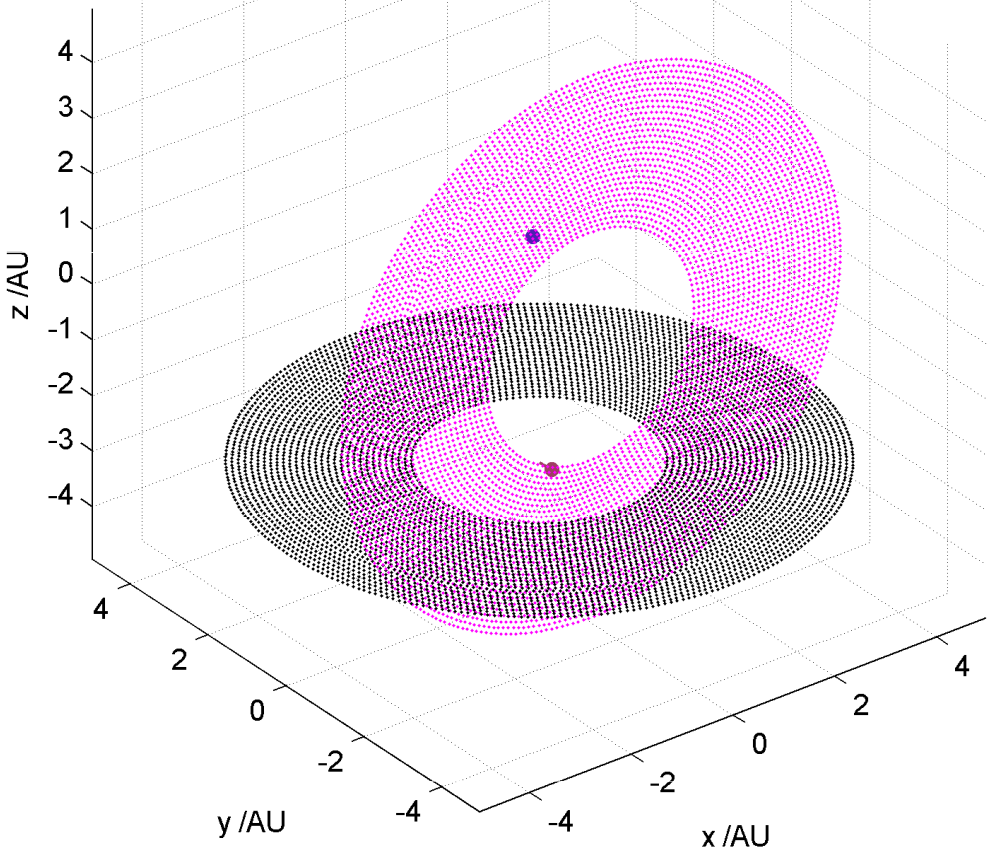
Foufs EVLF TPMJOVT, BFHFPO, Hbpmfs, Pggjdfst, boe puifs
Buufoebout
BFHFPO
Qspdffe, Tpmjovt, up qspdvsf nz gbmm
Boe cz uif eppn pg efbui foe xpft boe bmm£

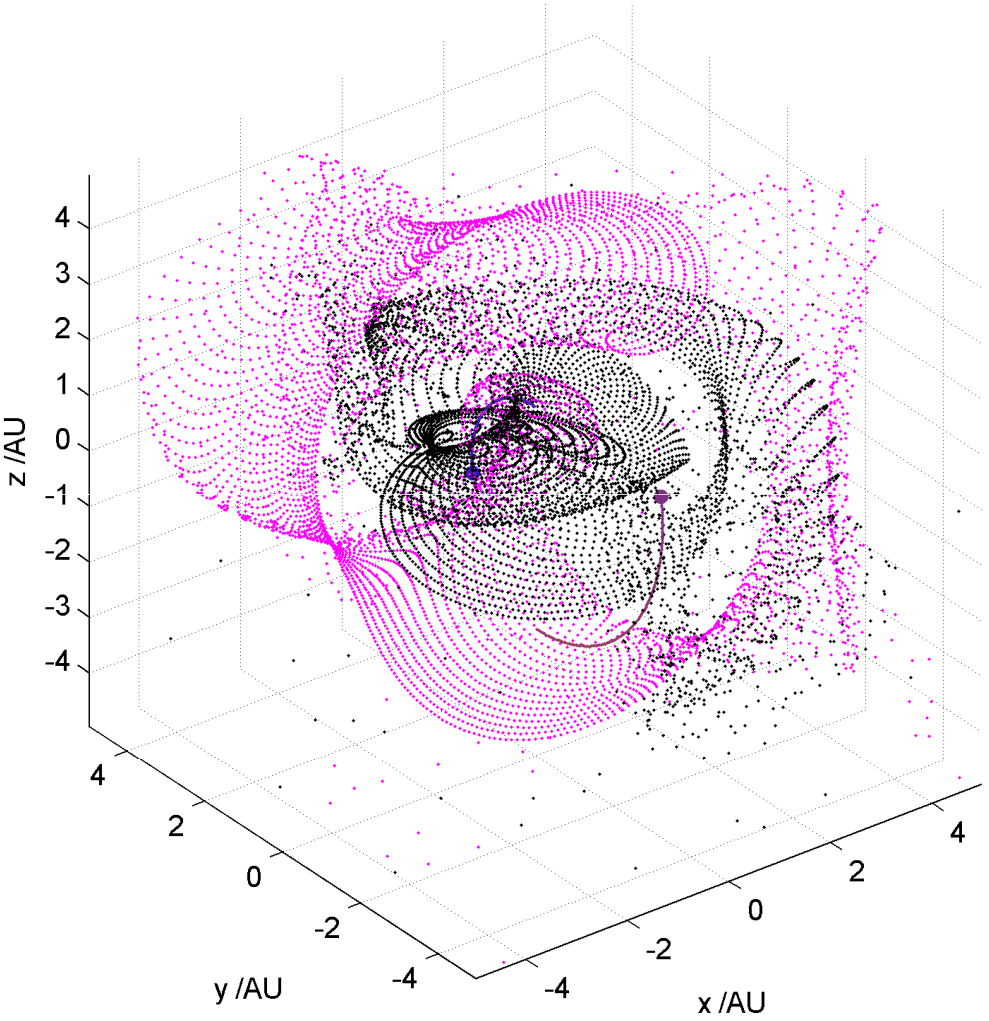
5. Nuclear binding energy

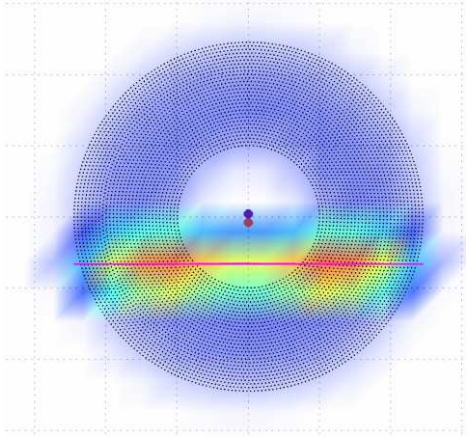
carbon	nitrogen	oxygen
6	7	8
C	N	O
12.011	14.007	15.999

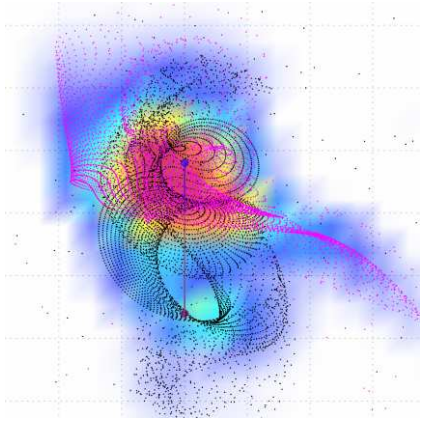


6. Gravity Simulation





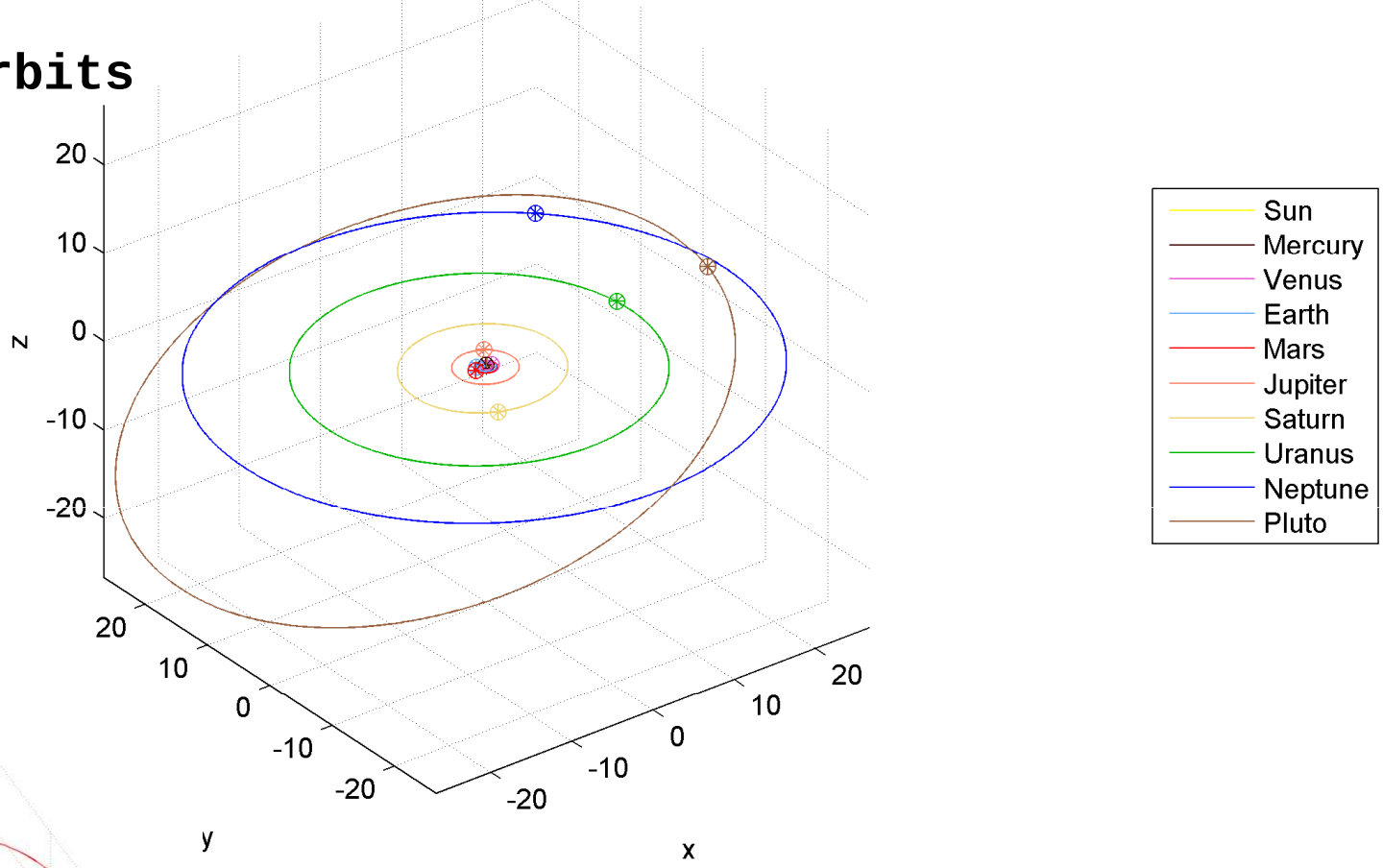


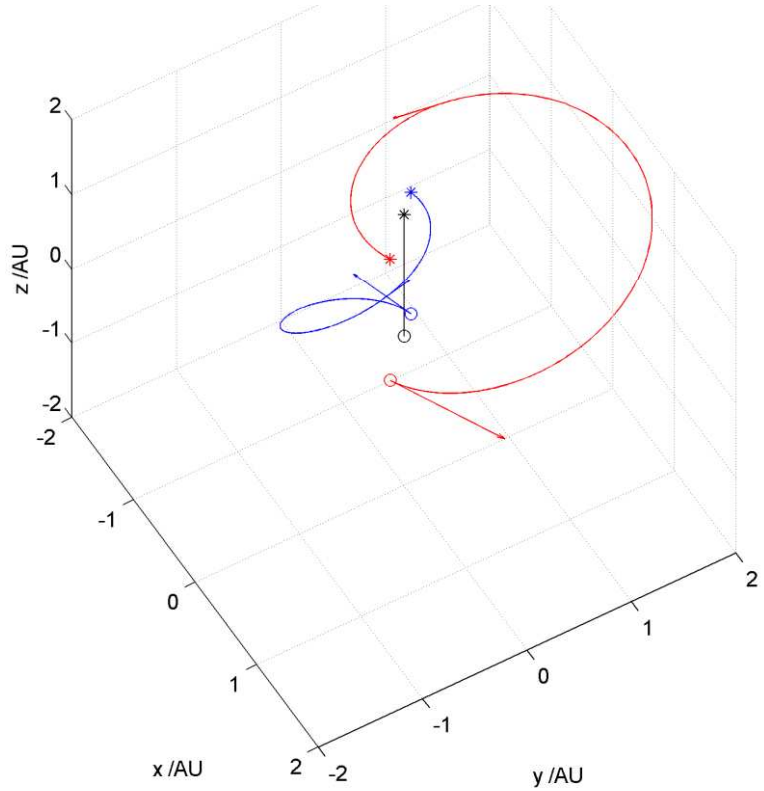


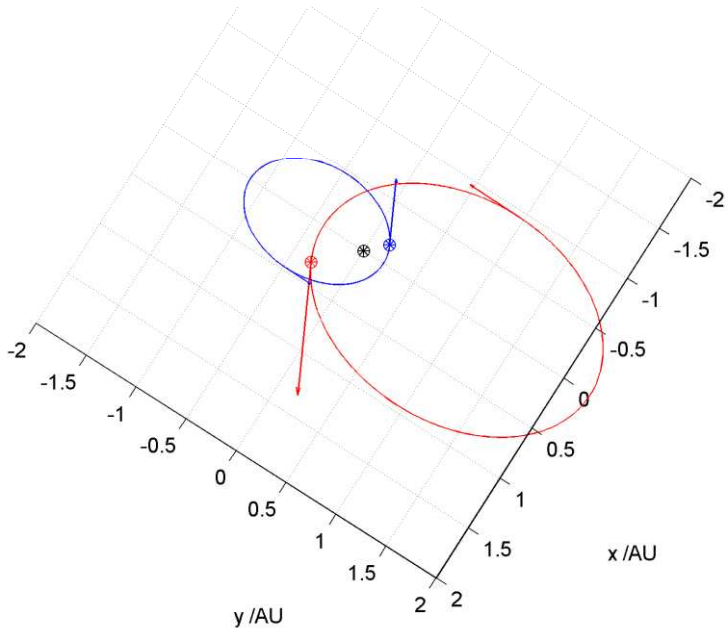
7. Elliptical orbits

$$r = \frac{a\left(1-\varepsilon^2\right)}{1+\varepsilon\cos\theta}$$

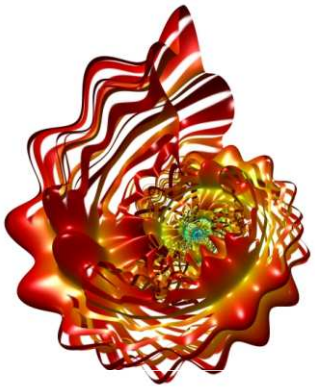
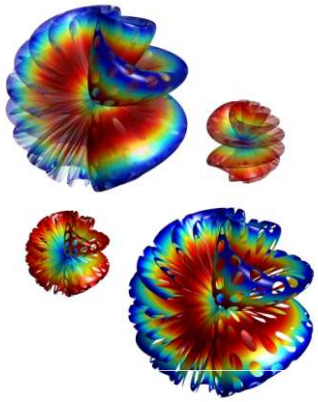
$$\varepsilon = \sqrt{1-\frac{b^2}{a^2}}$$



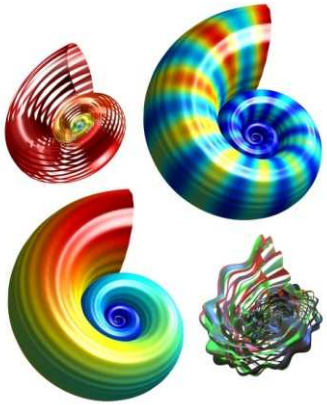


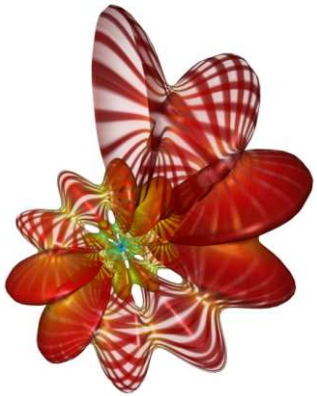
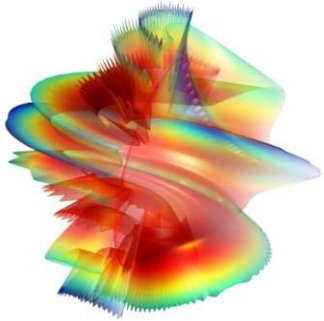
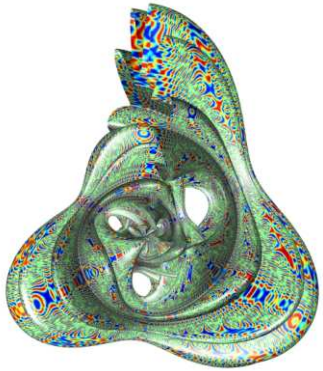
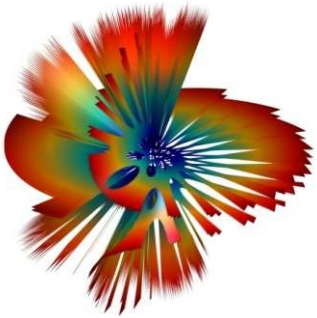


8. Mathematicon Exhibition



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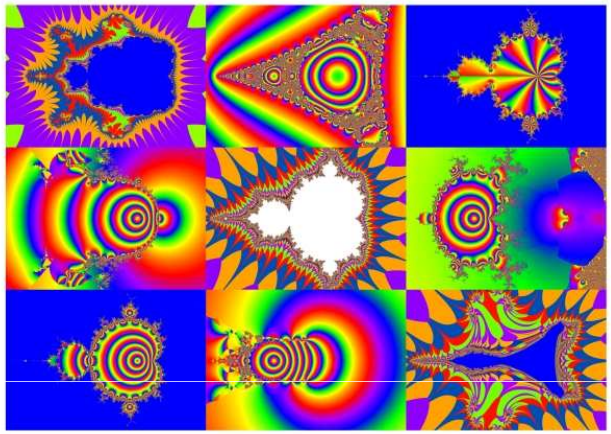
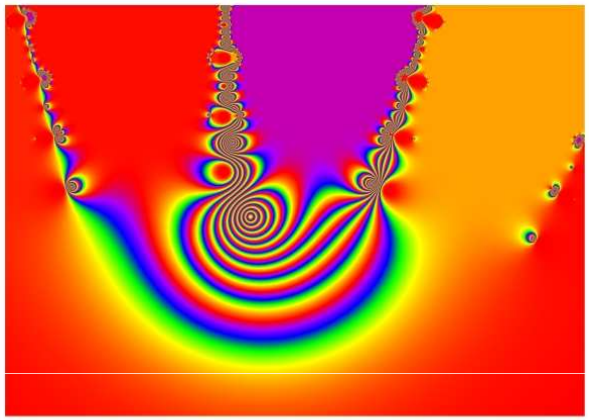
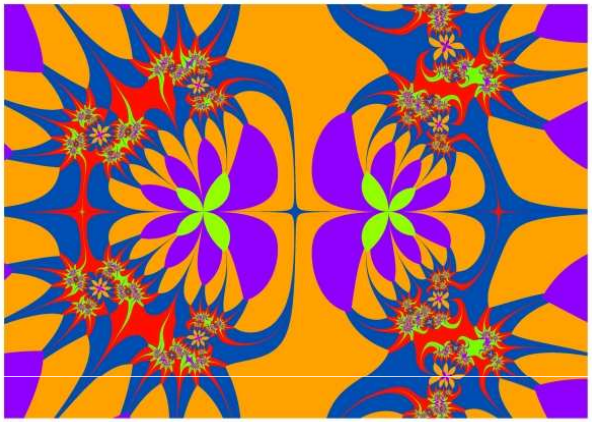
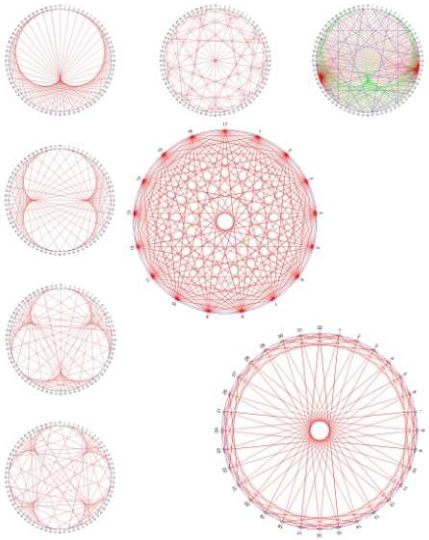
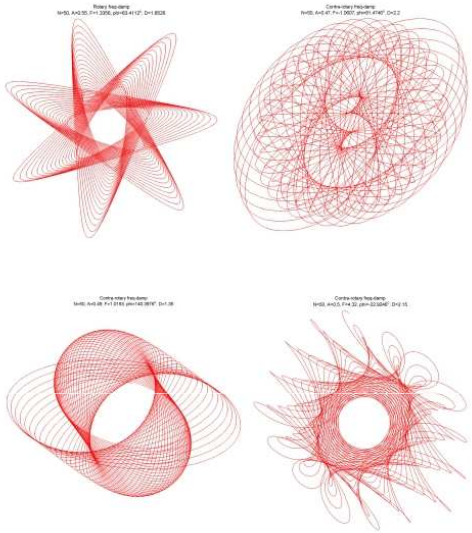
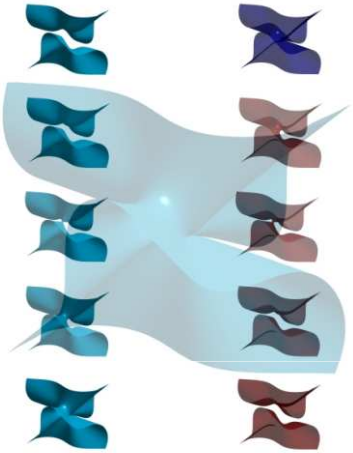


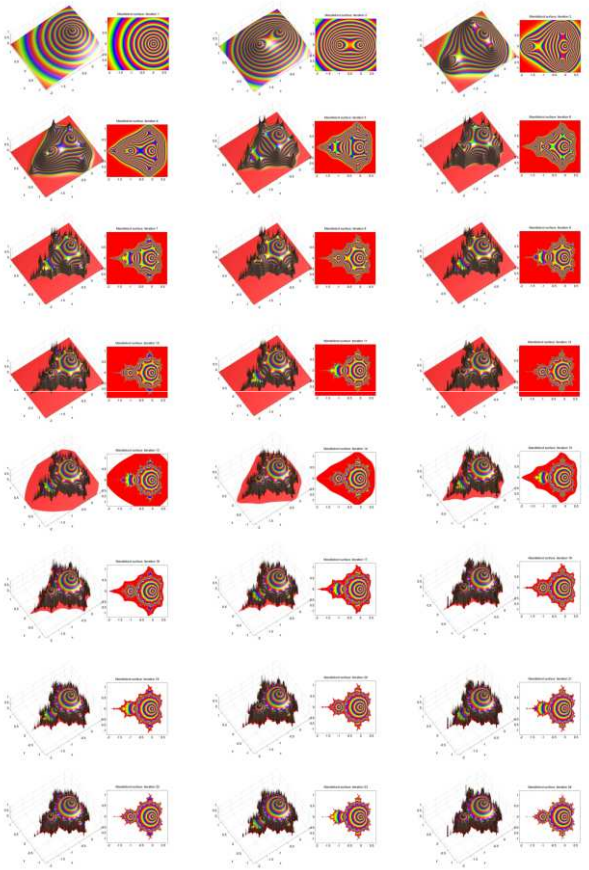






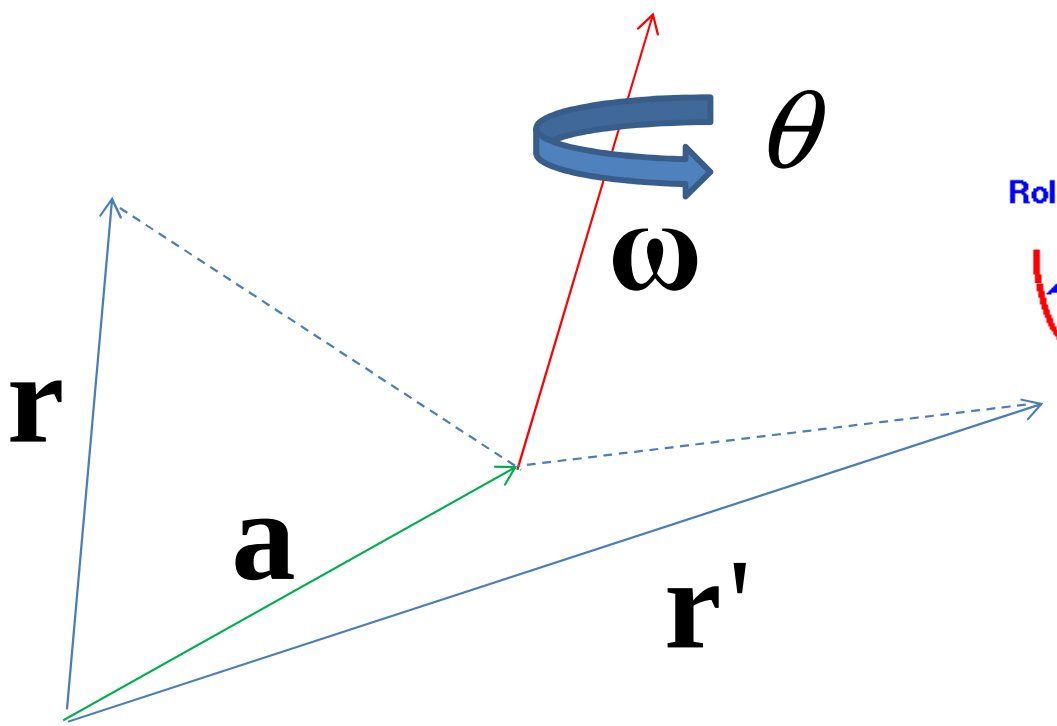


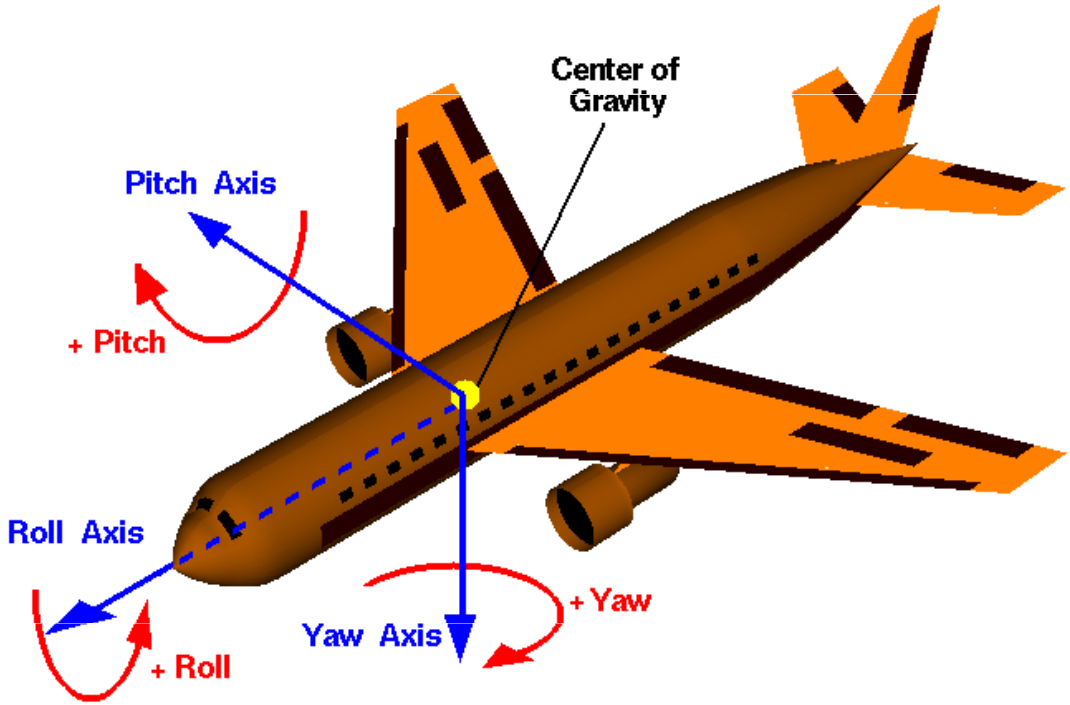




9. Rodriguez's rotation formula

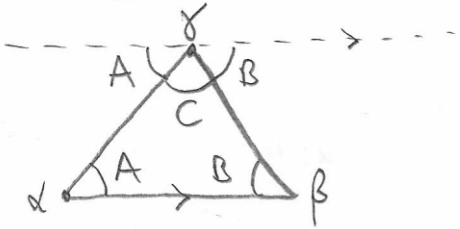
$$\mathbf{r}' = \mathbf{a}(1-\cos\theta) + \mathbf{r}\cos\theta + \frac{\boldsymbol{\omega}\times(\mathbf{r}-\mathbf{a})}{|\boldsymbol{\omega}|}\sin\theta + \frac{(\mathbf{r}\cdot\boldsymbol{\omega}-\mathbf{a}\cdot\boldsymbol{\omega})(1-\cos\theta)}{|\boldsymbol{\omega}|^2}\boldsymbol{\omega}$$





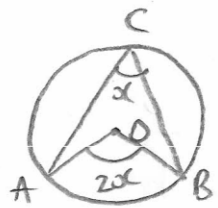
10. Circle theorems

Firstly we must prove the interior angles of a triangle sum to 180° (C1)

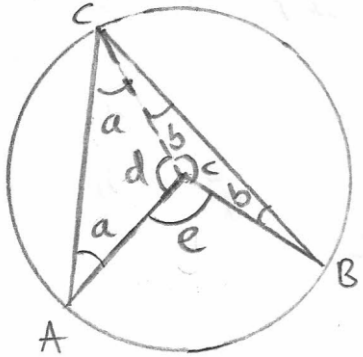


This can be achieved by drawing a line through the vertex of angle C (γ) which is // to line $\alpha\beta$

Next we will prove the "Arrowhead theorem"



(C2)



Split the arrowhead into two ISOCELES triangles. Using (C1)

$2a + d = 180^\circ$ ①

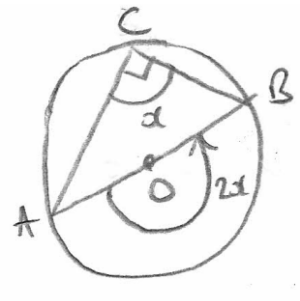
$2b + c = 180^\circ$ ② And also

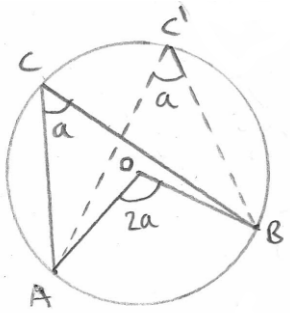
$d + c + e = 360^\circ$ ③

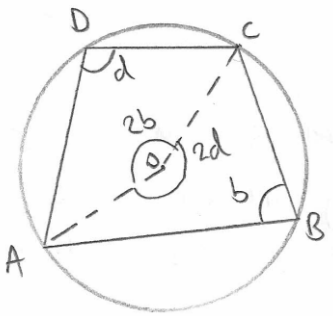
$\therefore$ ① + ② = ③ $\Rightarrow 2a + 2b + d + c = d + c + e$

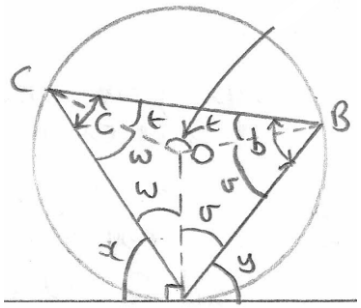
$\Rightarrow \boxed{2(a+b) = e}$

which proves the theorem

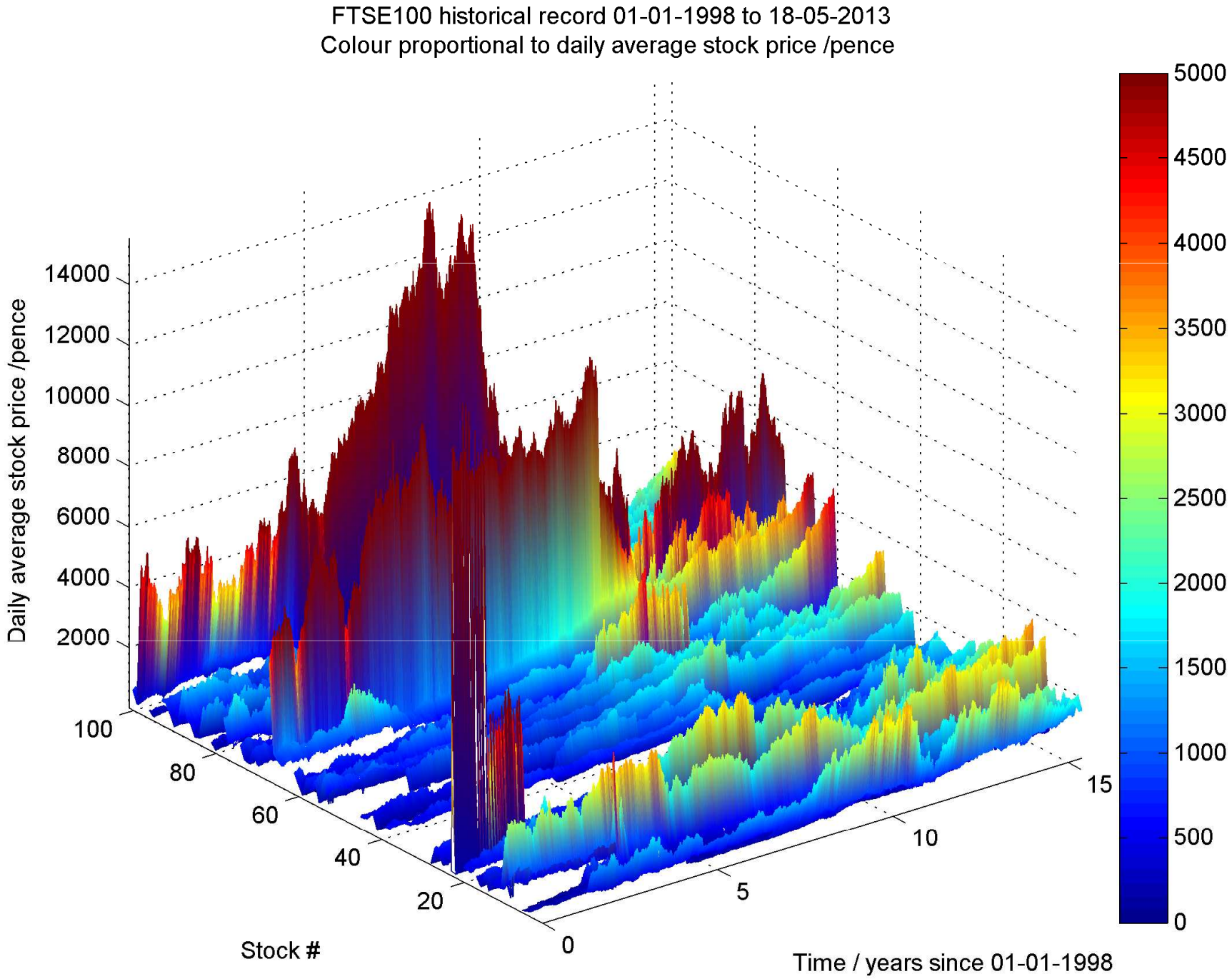








11. FTSE 100 stocks and shares

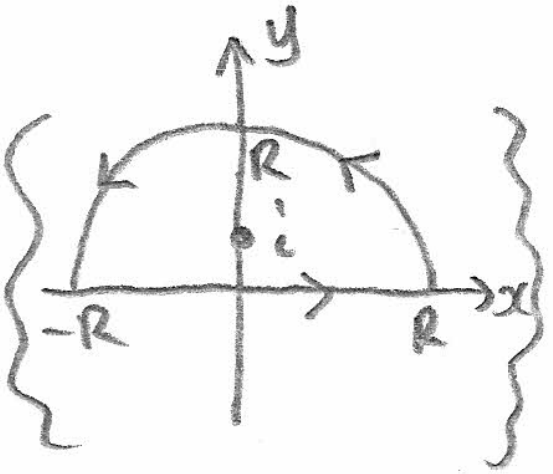


12. A most intriguing integral

$$\int_0^\infty \frac{2x\sin x}{1+x^2}\,dx = \frac{\pi}{e}$$

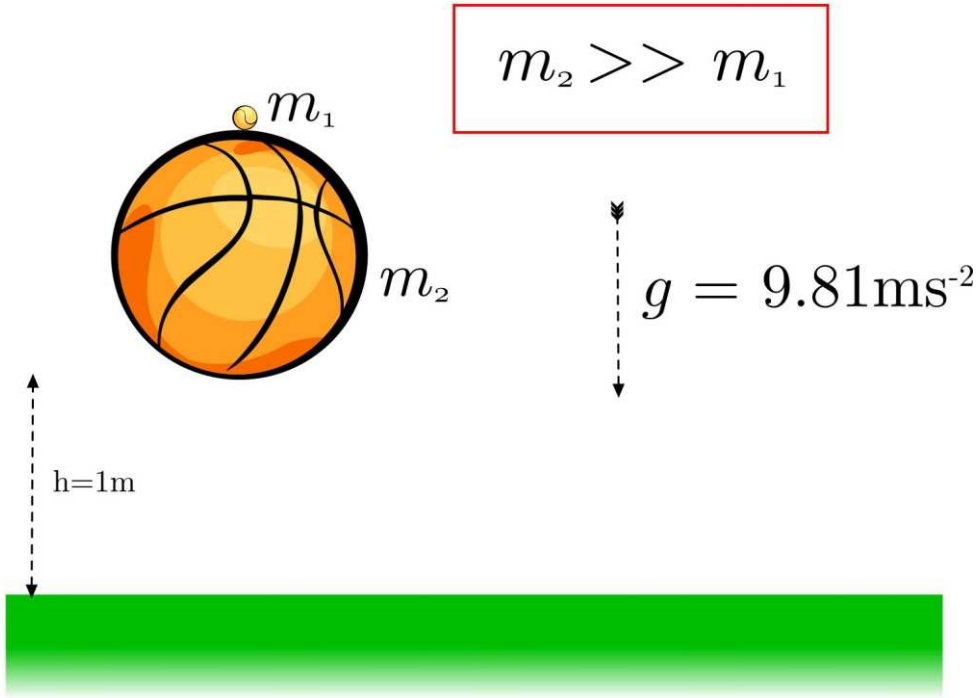
$$f(z) = \frac{ze^{iaz}}{1+z^2} = \frac{ze^{iaz}}{(z+i)(z-i)}$$

$$\oint_C f(z)\,dz = \lim_{R\to\infty}$$

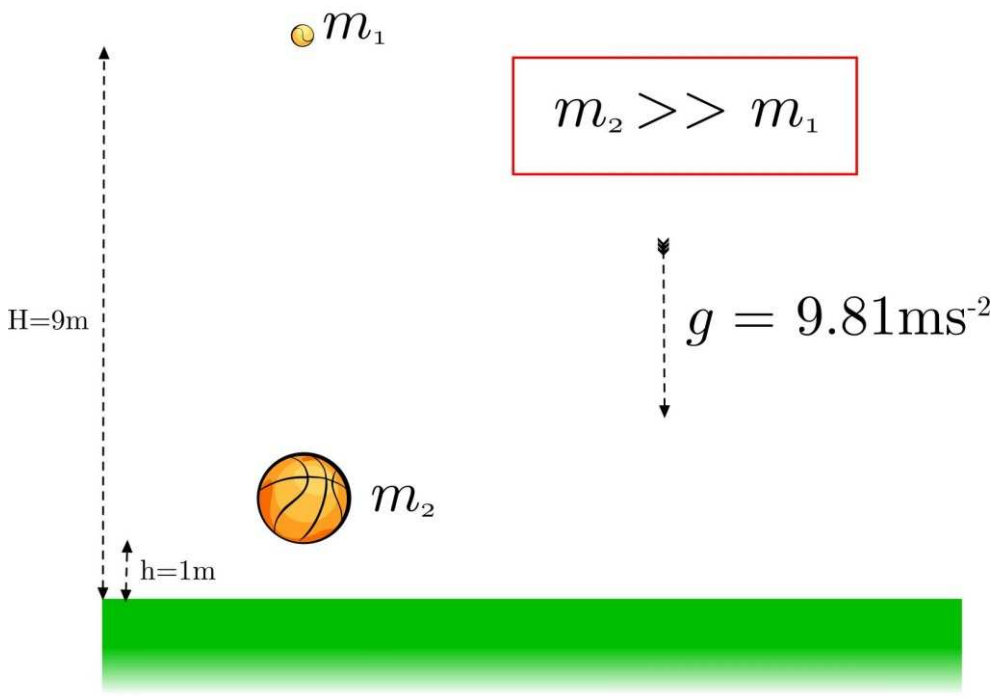


13. Velocity amplifying elastic collider

Balls are dropped from rest



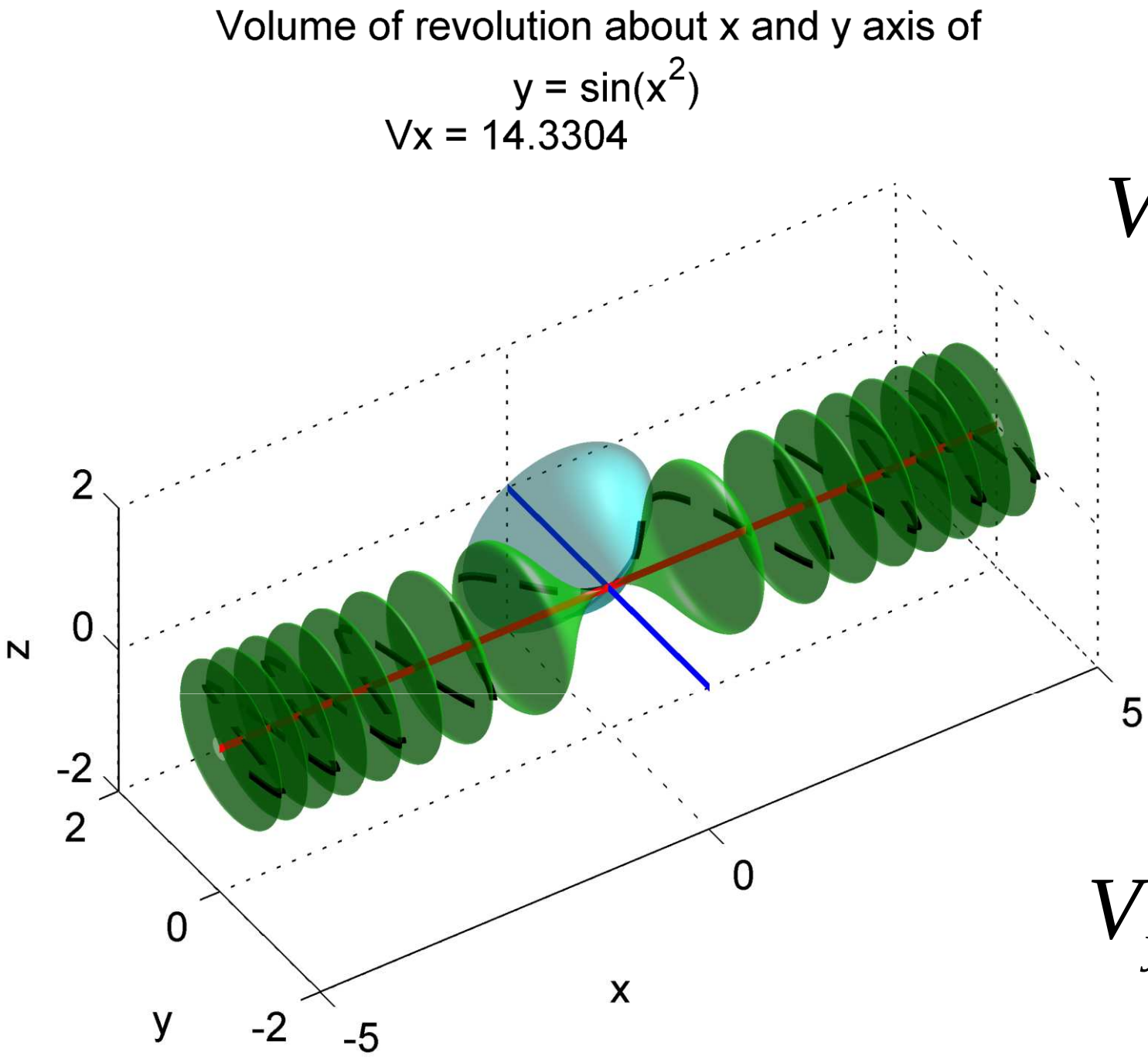
Following collision, the smaller mass rises up to *nine times* the distance fallen!



$$v_1 = u\left(\frac{3 - m_1/m_2}{1 + m_1/m_2}\right)$$

$$u^2 = 2gh$$

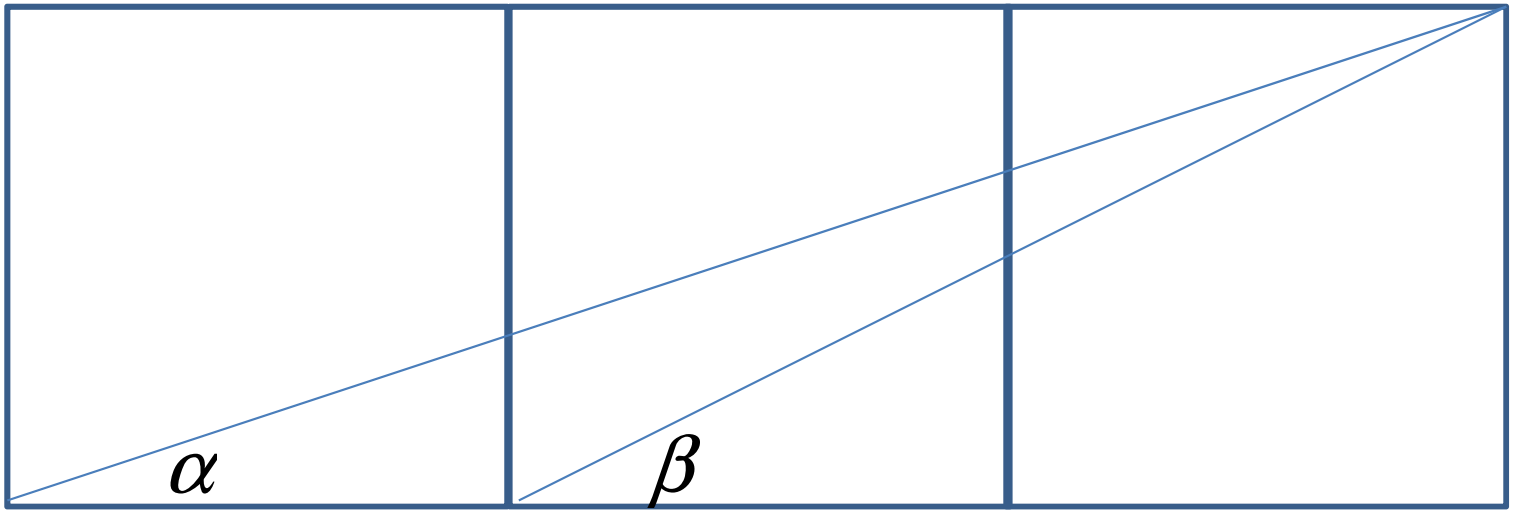
14. Volumes of revolution

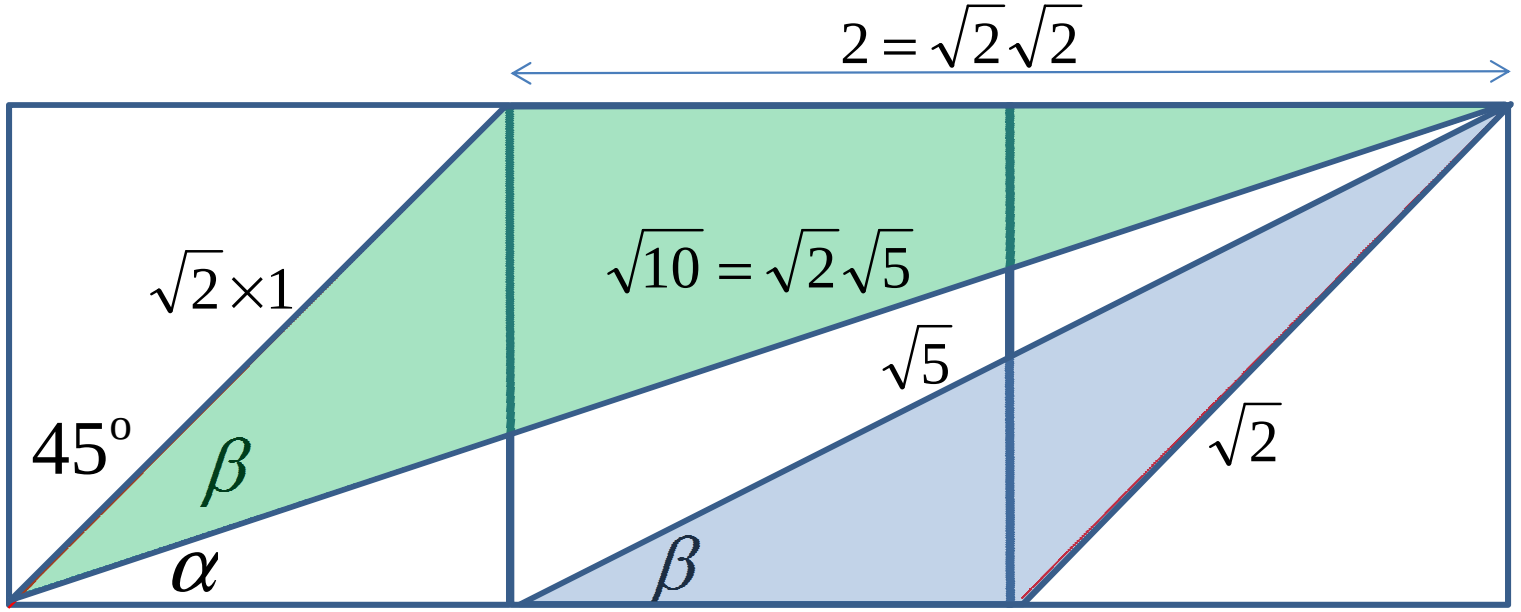


$$V_x = \int_a^b \pi y^2 dx$$

$$V_y = \int_A^B \pi x^2 dy$$

15. Three squares 45 degree angle problem





1

$\alpha+\beta=45^{o}$

Similar triangles! Scale factor $\sqrt{2}$

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Have a marvellous summer!