

Matemáticas y Fútbol

Fernando Rodriguez Villegas
ICTP
Febrero, 2019





ITALY
1934

Federale 102



FRANCE
1938

Allen



BRAZIL
1950

Superball Duplo T



SWITZERLAND
1954

Swiss World Champion



SWEDEN
1958

Top Star



CHILE
1962

Crack



ENGLAND
1966

Challenge 4-Stars



**GERMANY
1974**

Telstar Durlast



**ARGENTINA
1978**

Tango River Plate



**SPAIN
1982**

Tango España



**MEXICO
1986**

Azteca



**ITALY
1990**

Etrusco Unico



**UNITED STATES
1994**

Questa



**FRANCE
1998**

Tricolore



**KOREA/JAPAN
2002**

Fevernova



**GERMANY
2006**
Teamgeist



**SOUTH AFRICA
2010**
Jabulani



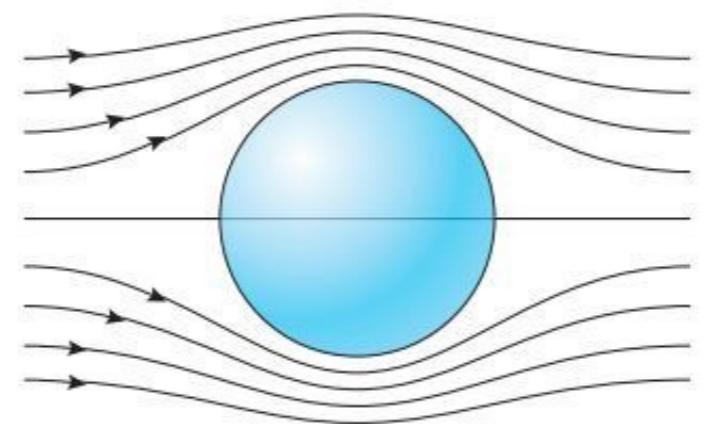
1930



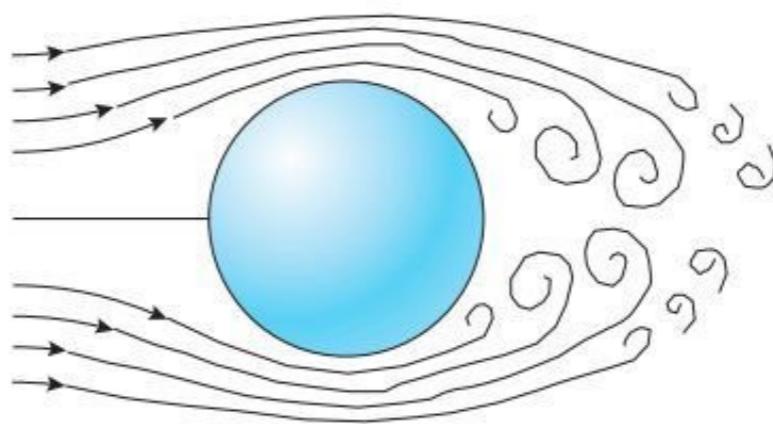
2018

Pelotas de los Mundiales

Física



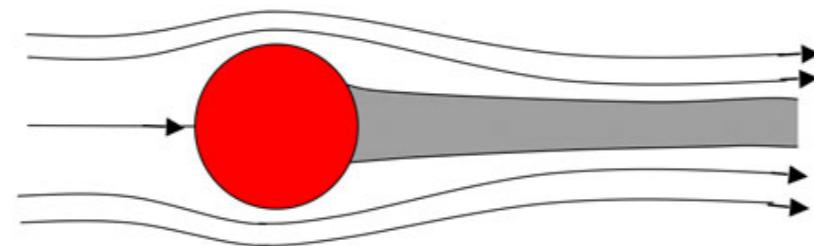
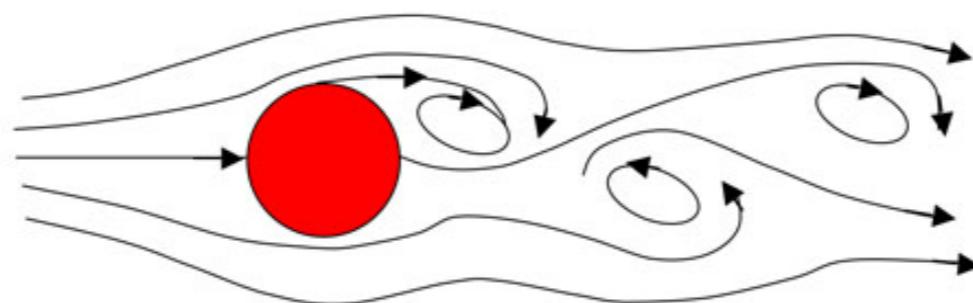
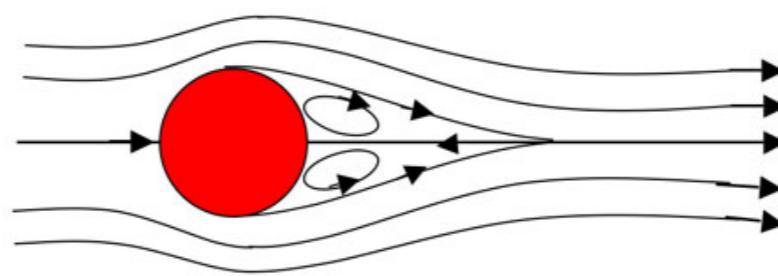
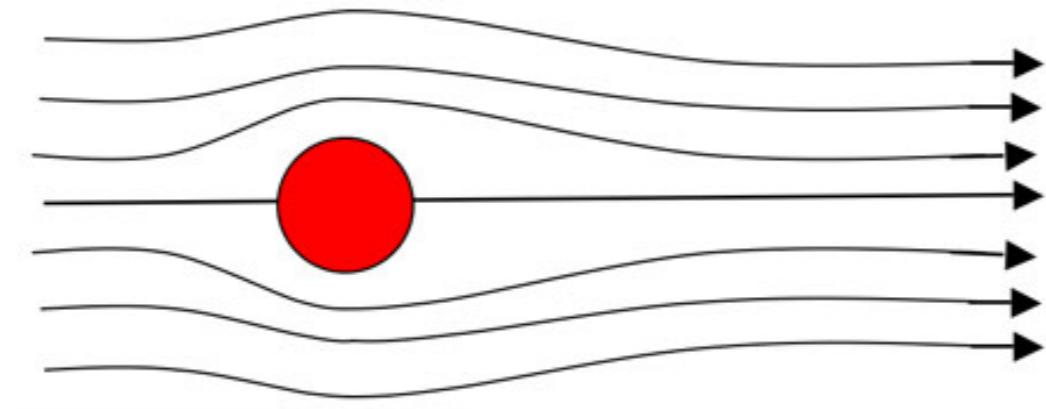
(a)

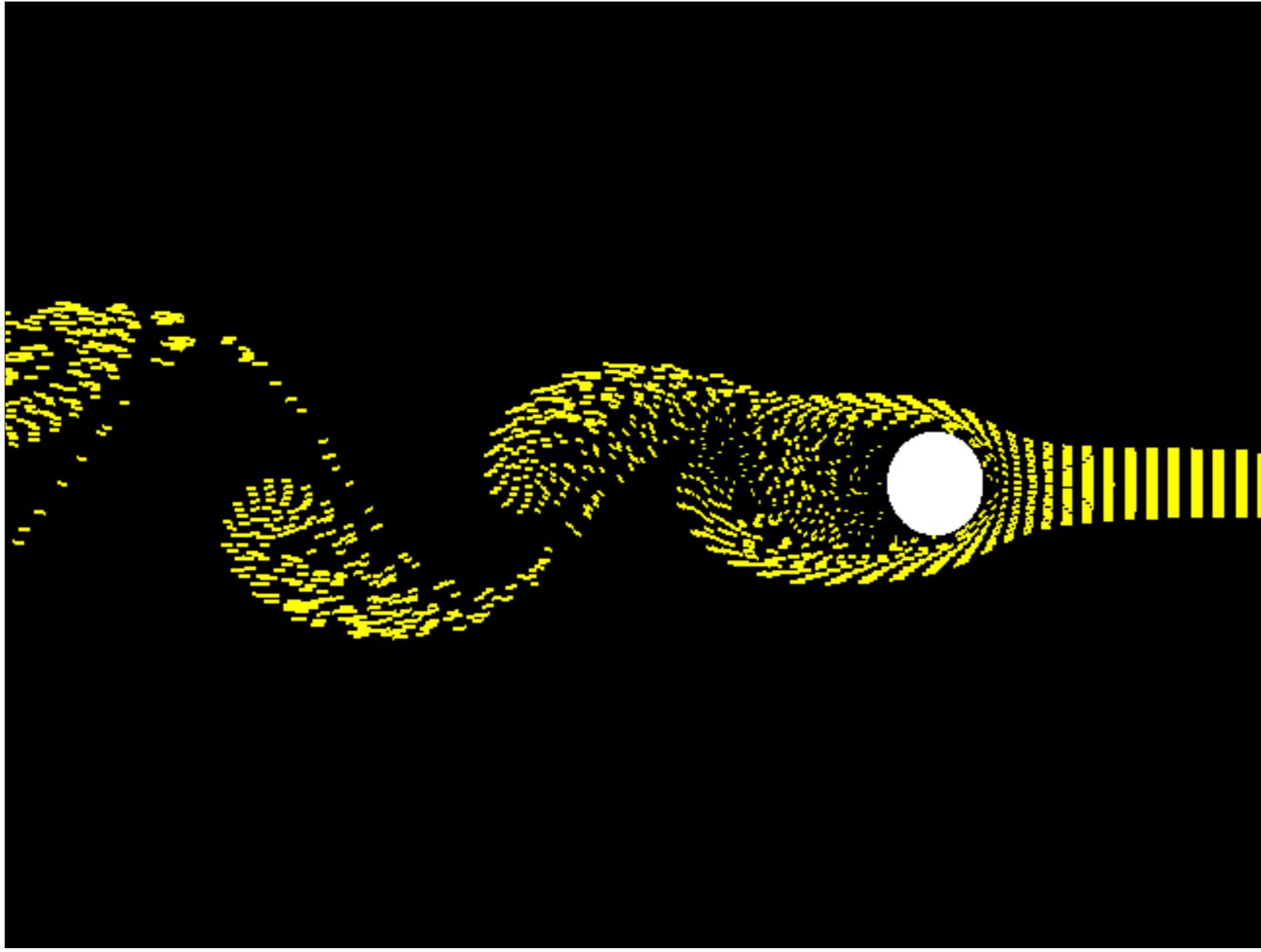


(b)

Laminar

Turbulento

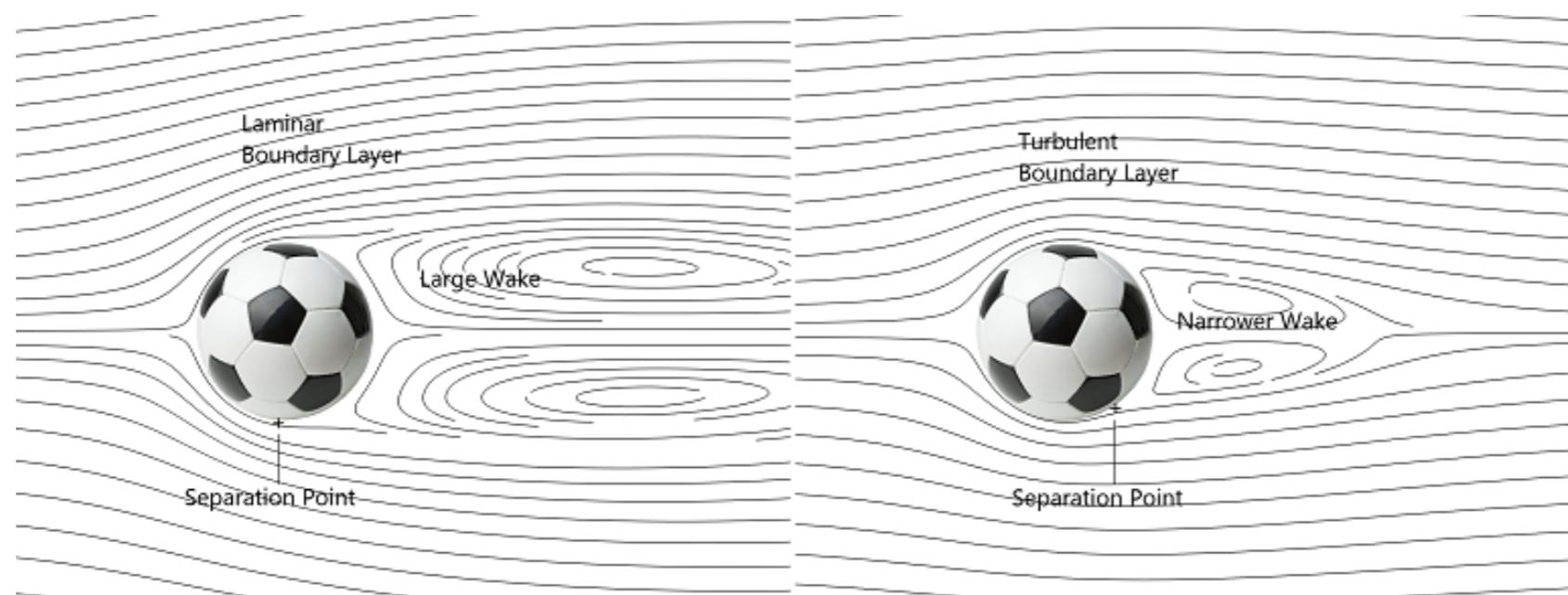
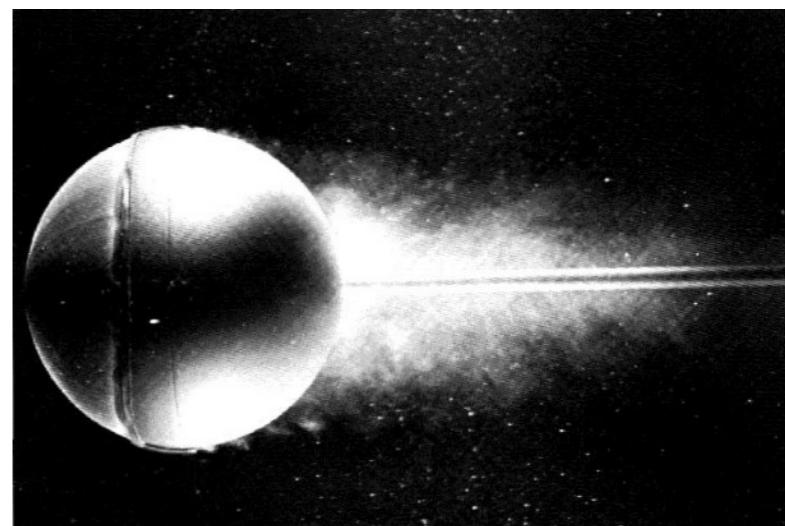
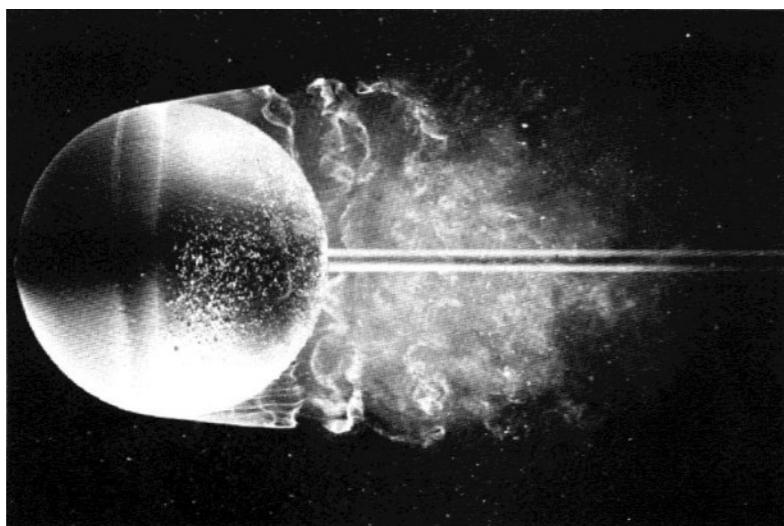




Turbulencia

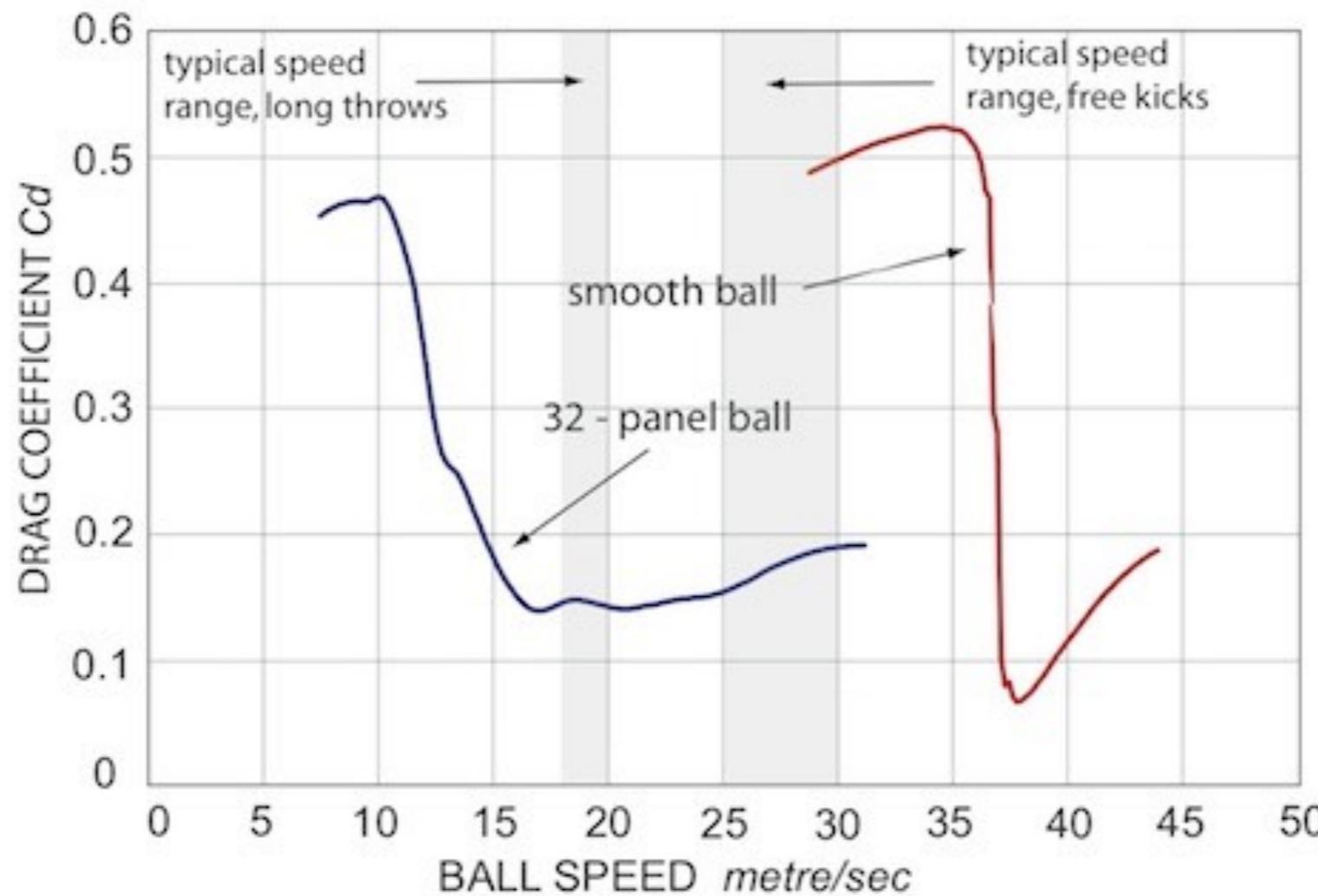


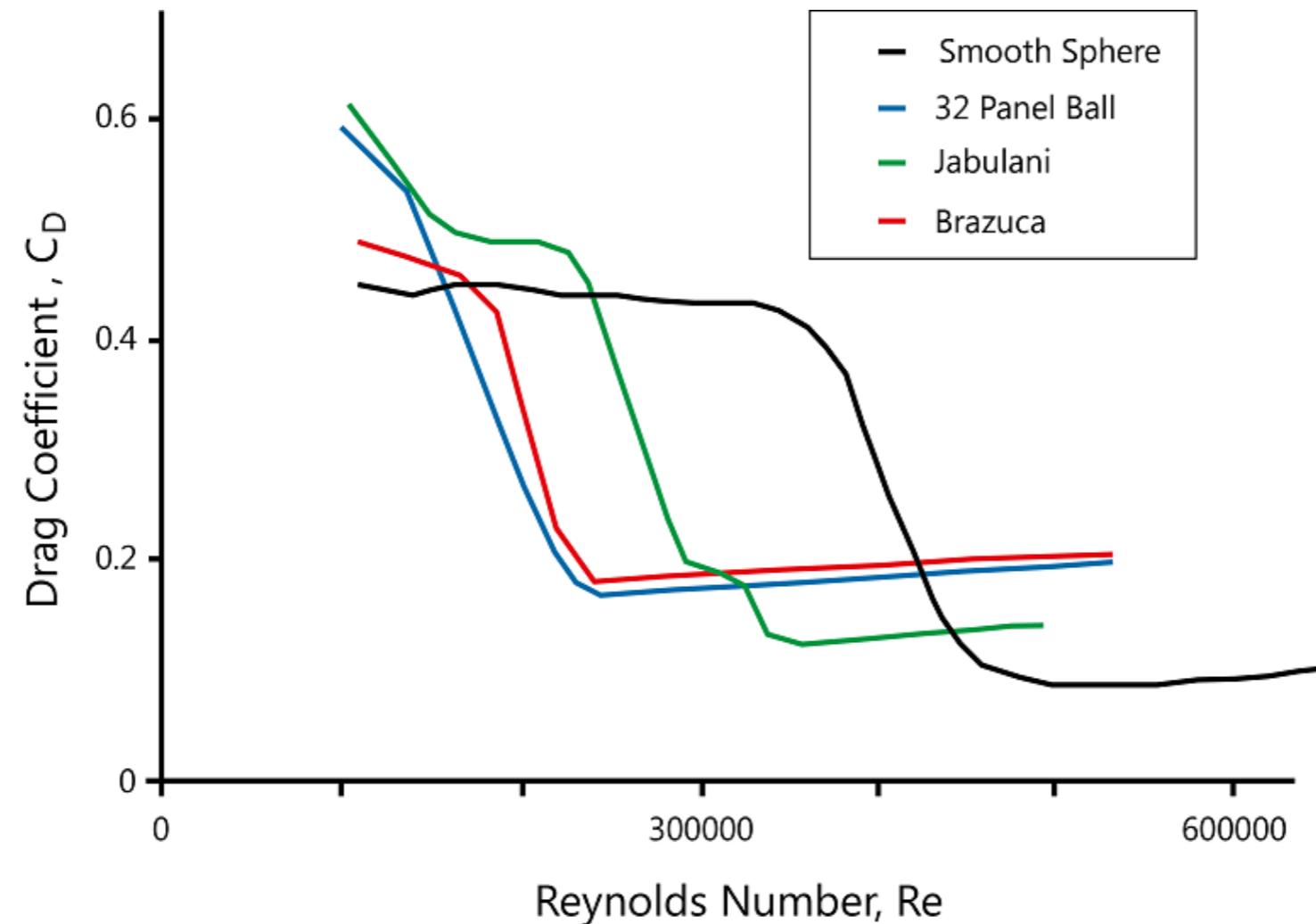
Vórtices de von Kármán

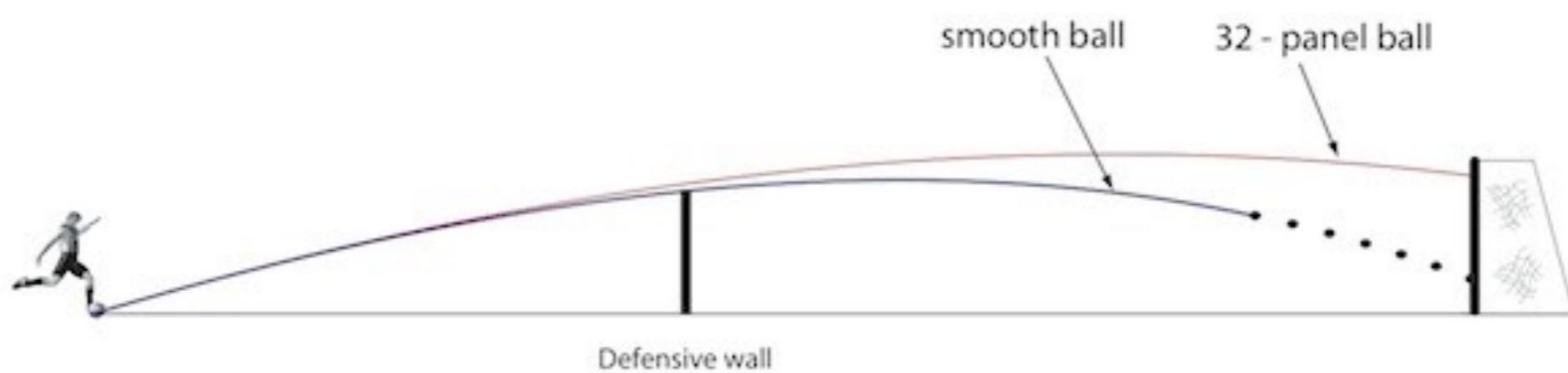


Fuerza de arrastre

$$F = \frac{1}{2} C_d \rho A V^2$$

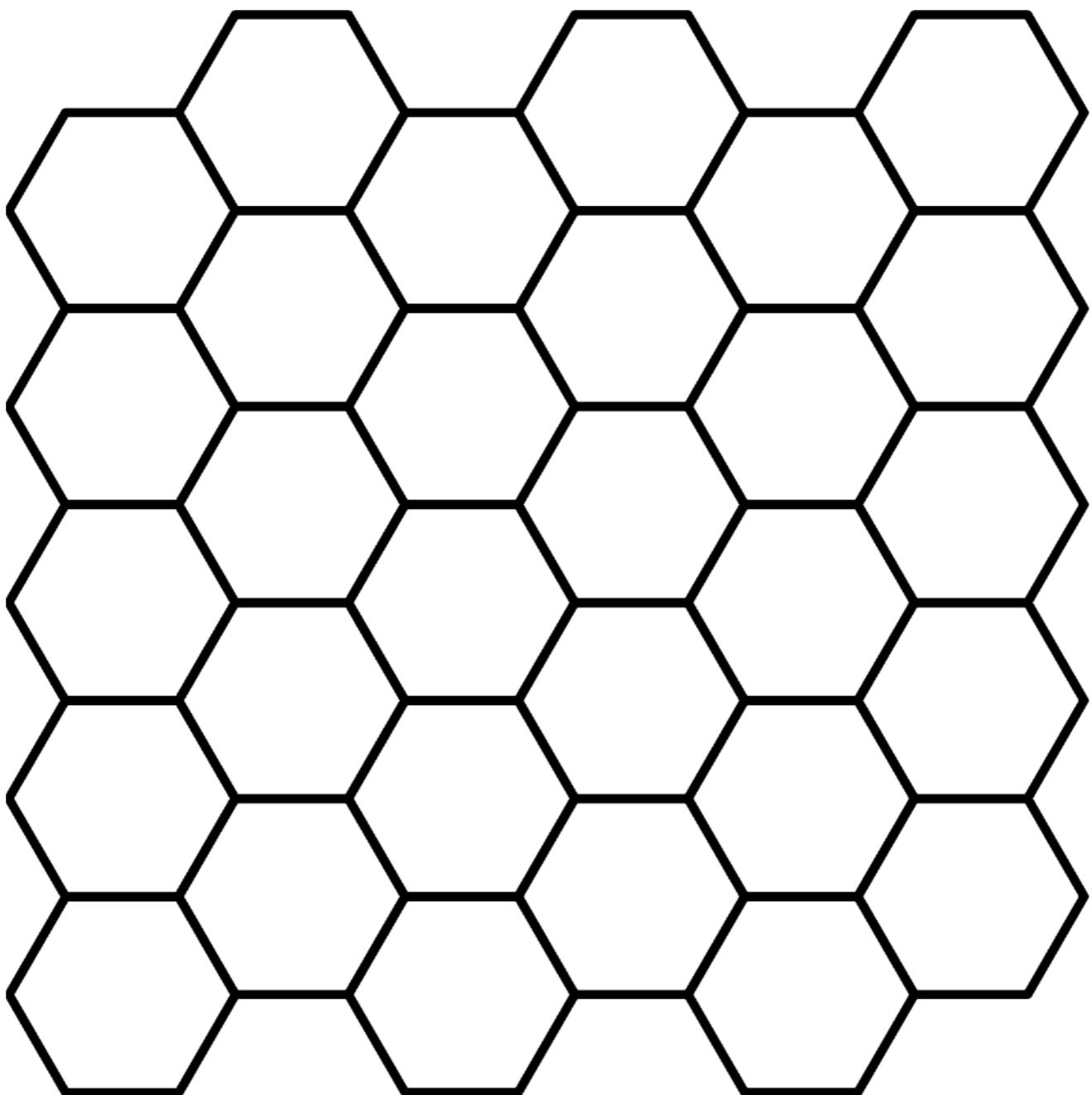


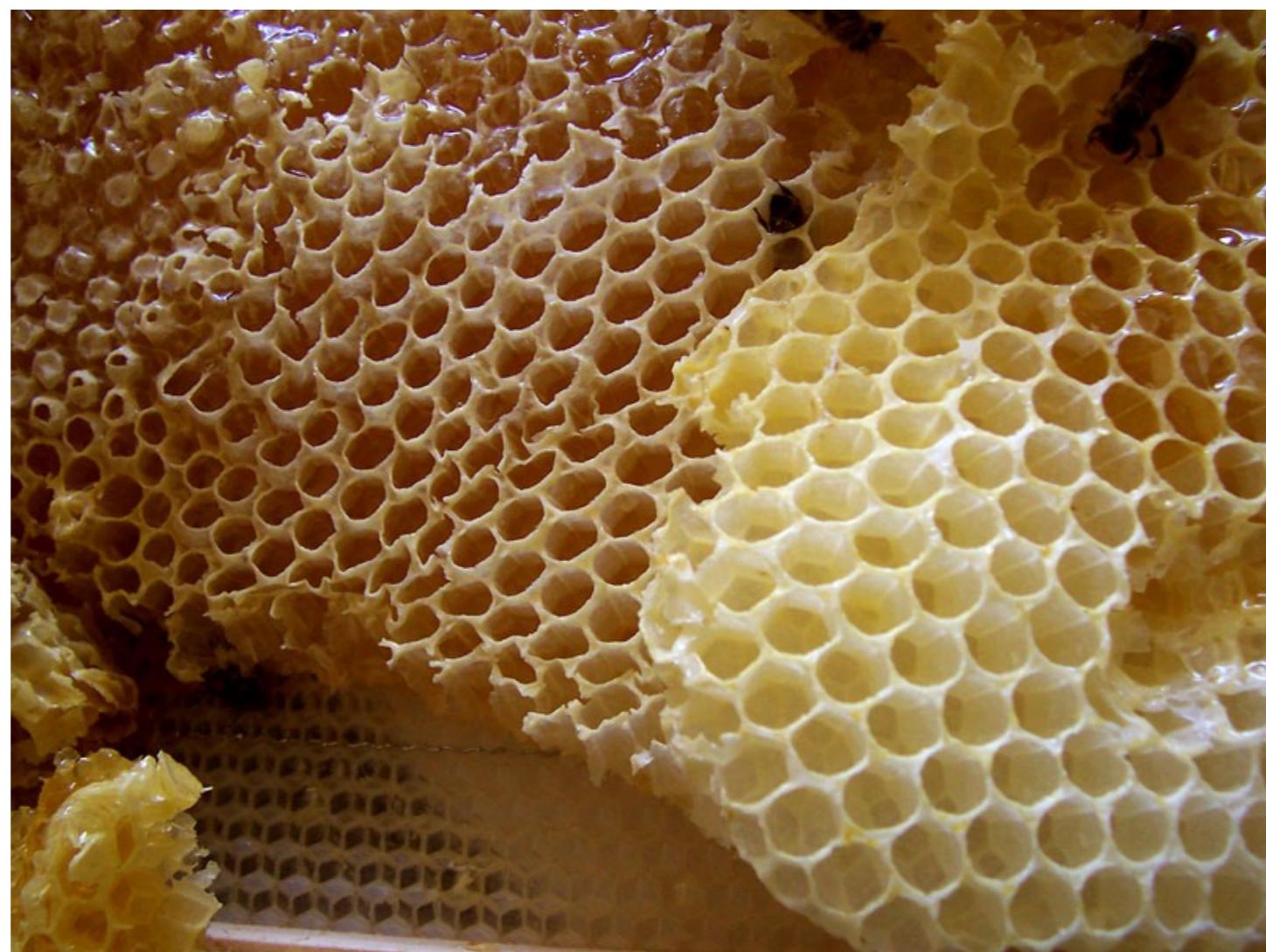




Matemáticas

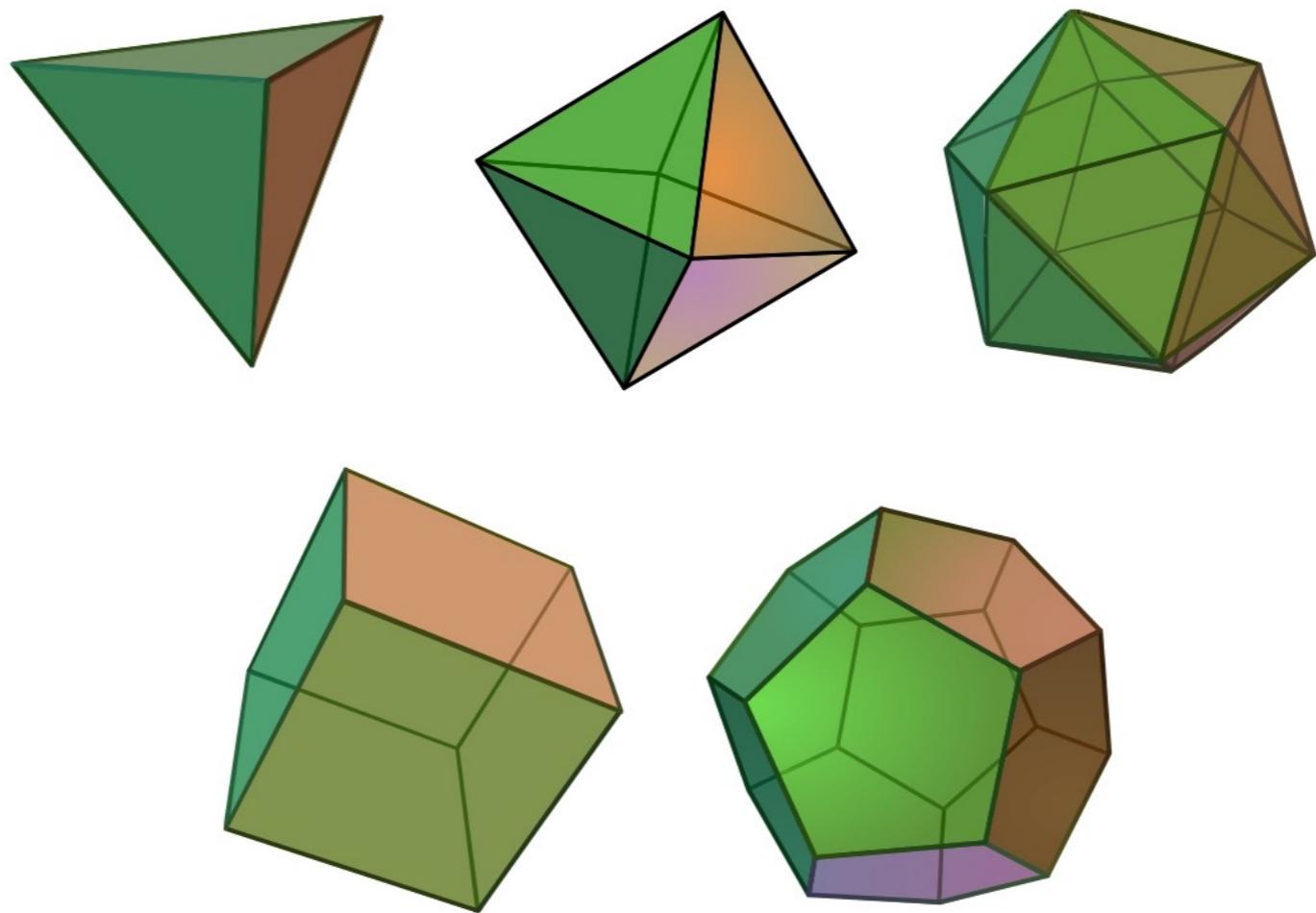
**Hay un número limitado
de estructuras simétricas**







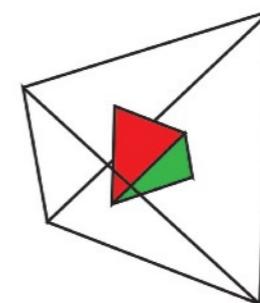
Penrose



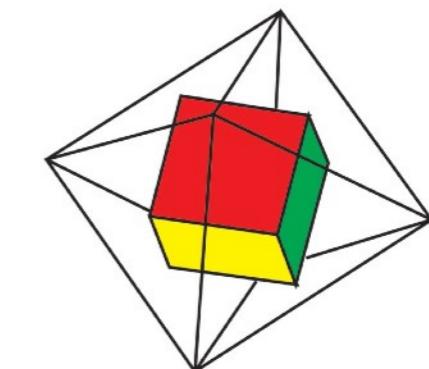
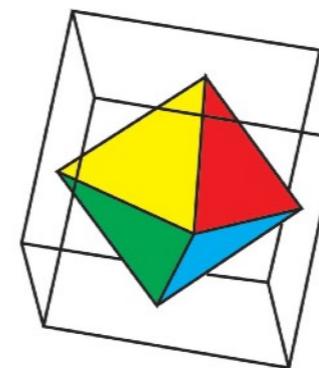
Sólidos Platónicos

Tres tipos de simetría

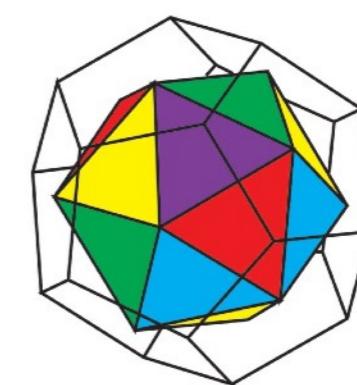
Tetrahedro

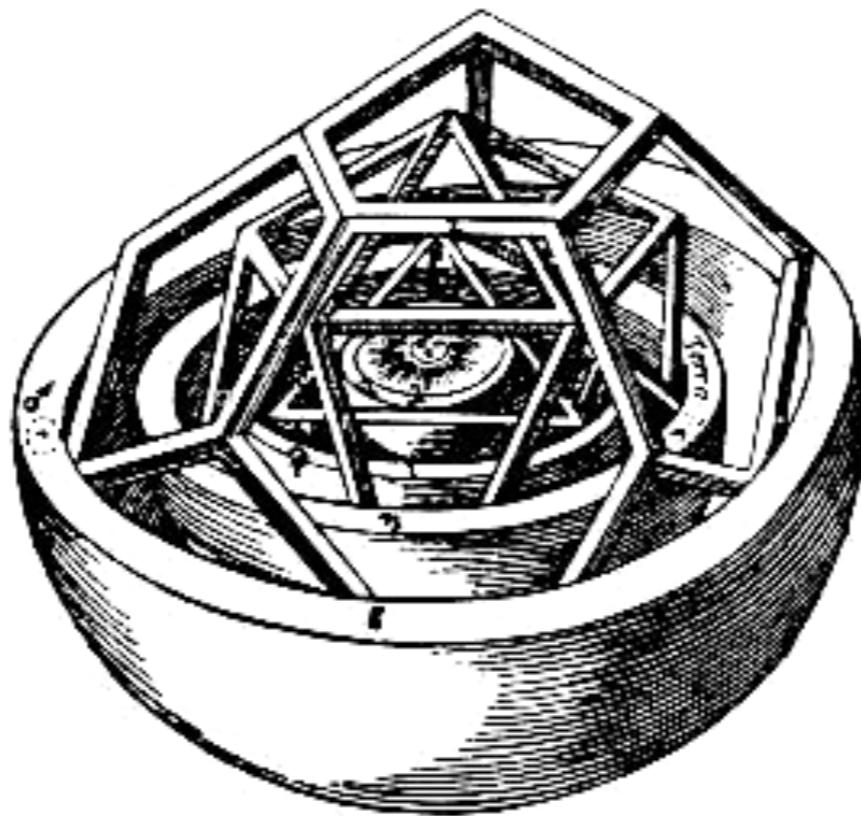


Octahedro - Cubo



Dodecahedro - Icosahedro





Kepler

Mysterium Cosmographicum (1596)



Dodecahedro Romano



Dodecahedro/Icosahedro

Fórmula de Euler

$$F - E + V = 2$$

Dodecahedro

$$F = 12$$

$$V = 20$$

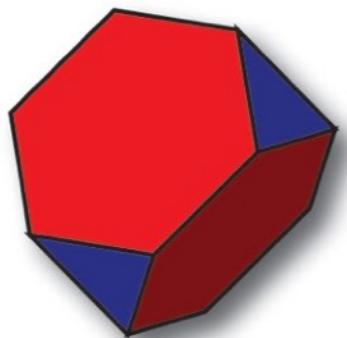
$$E = 30$$

Icosahedro

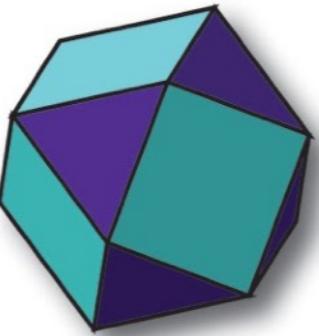
$$F = 20$$

$$V = 12$$

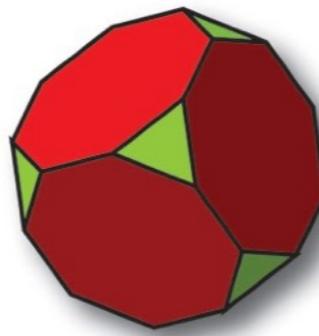
$$E = 30$$



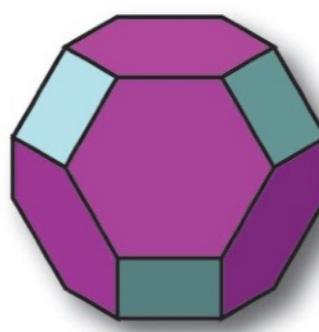
TRUNCATED TETRAHEDRON



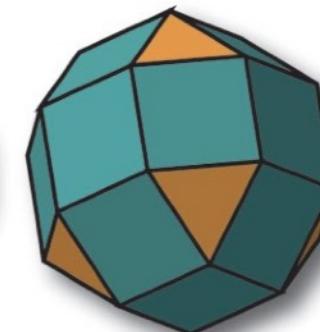
CUBOCTOHEDRON



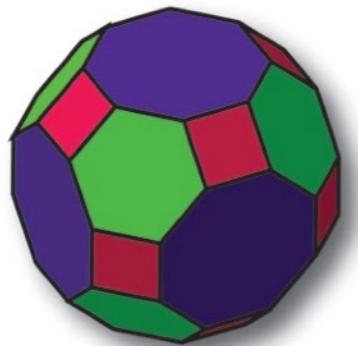
TRUNCATED CUBE



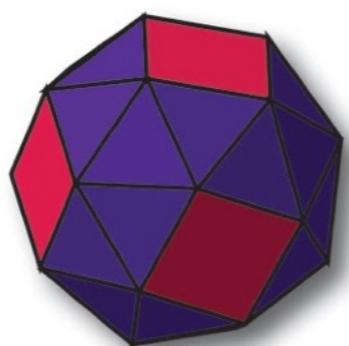
TRUNCATED OCTOHEDRON



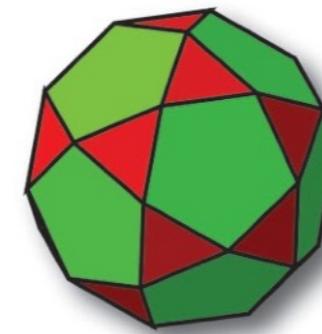
RHOMBICUBOCTOHEDRON



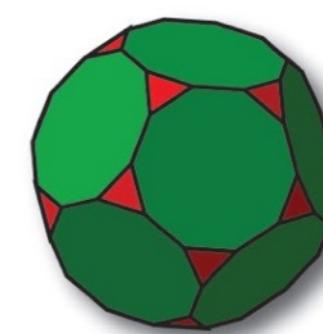
TRUNCATED CUBOCTOHEDRON



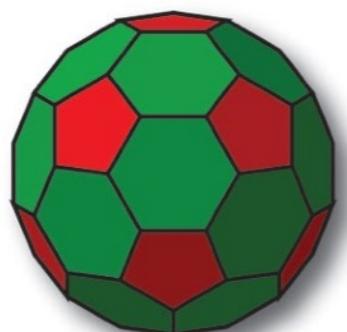
SNUB CUBE



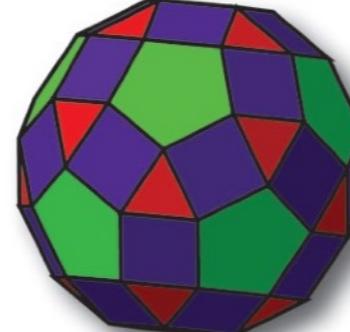
ICOSIDODECAHEDRON



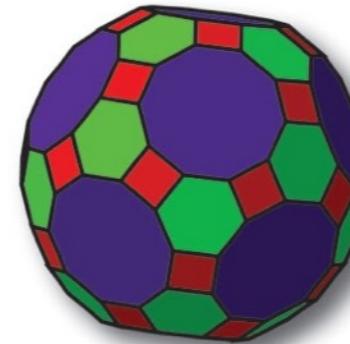
TRUNCATED DODECAHEDRON



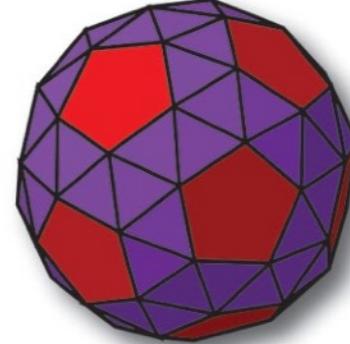
TRUNCATED ICOSAHEDRON



RHOMBICOSIDODECAHEDRON

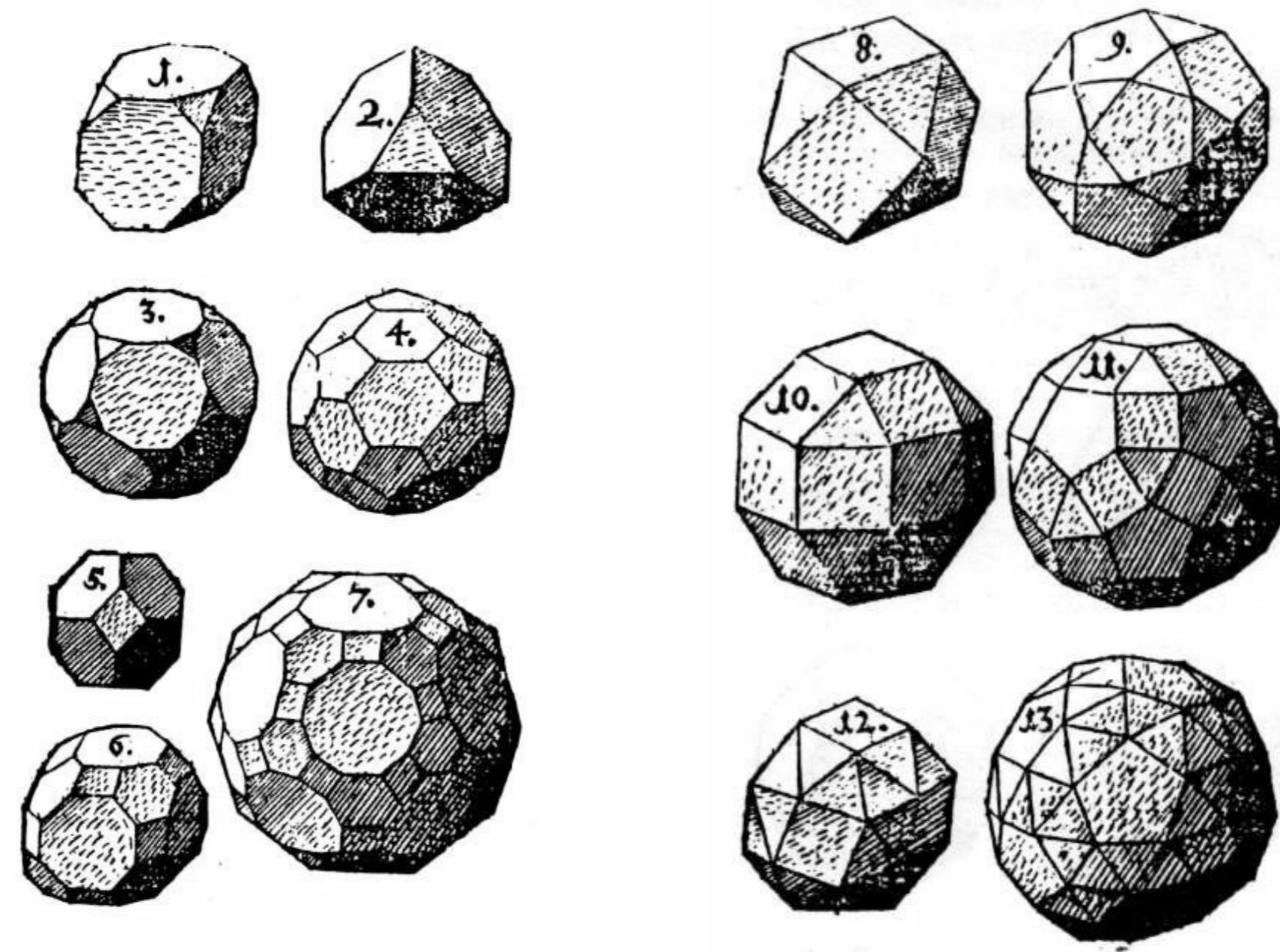


TRUNCATED ICOSIDODECAHEDRON



SNUB DODECAHEDRON

Sólidos de Arquímides



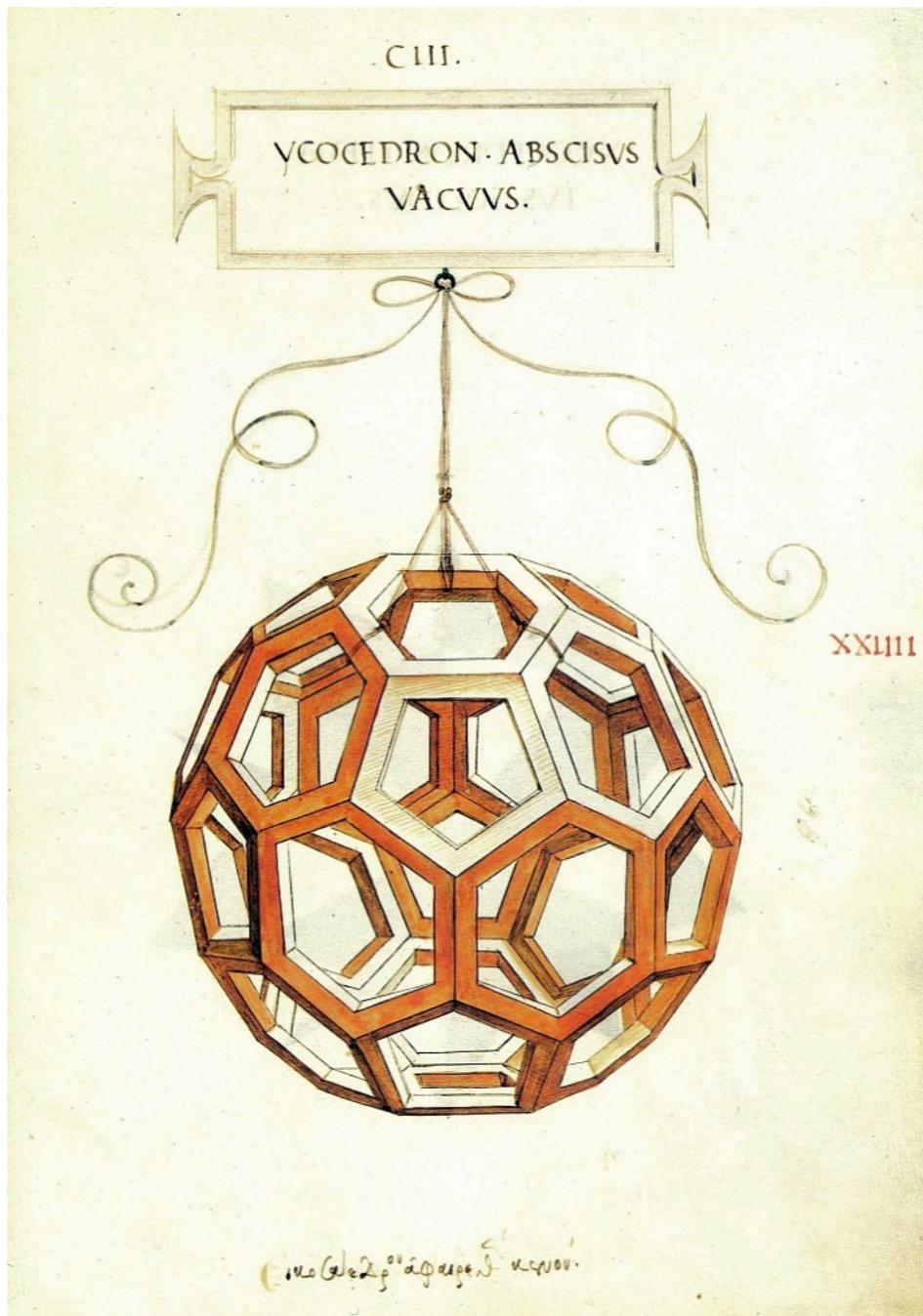
Kepler

Icosahedro truncado

$$F = 12 + 20$$

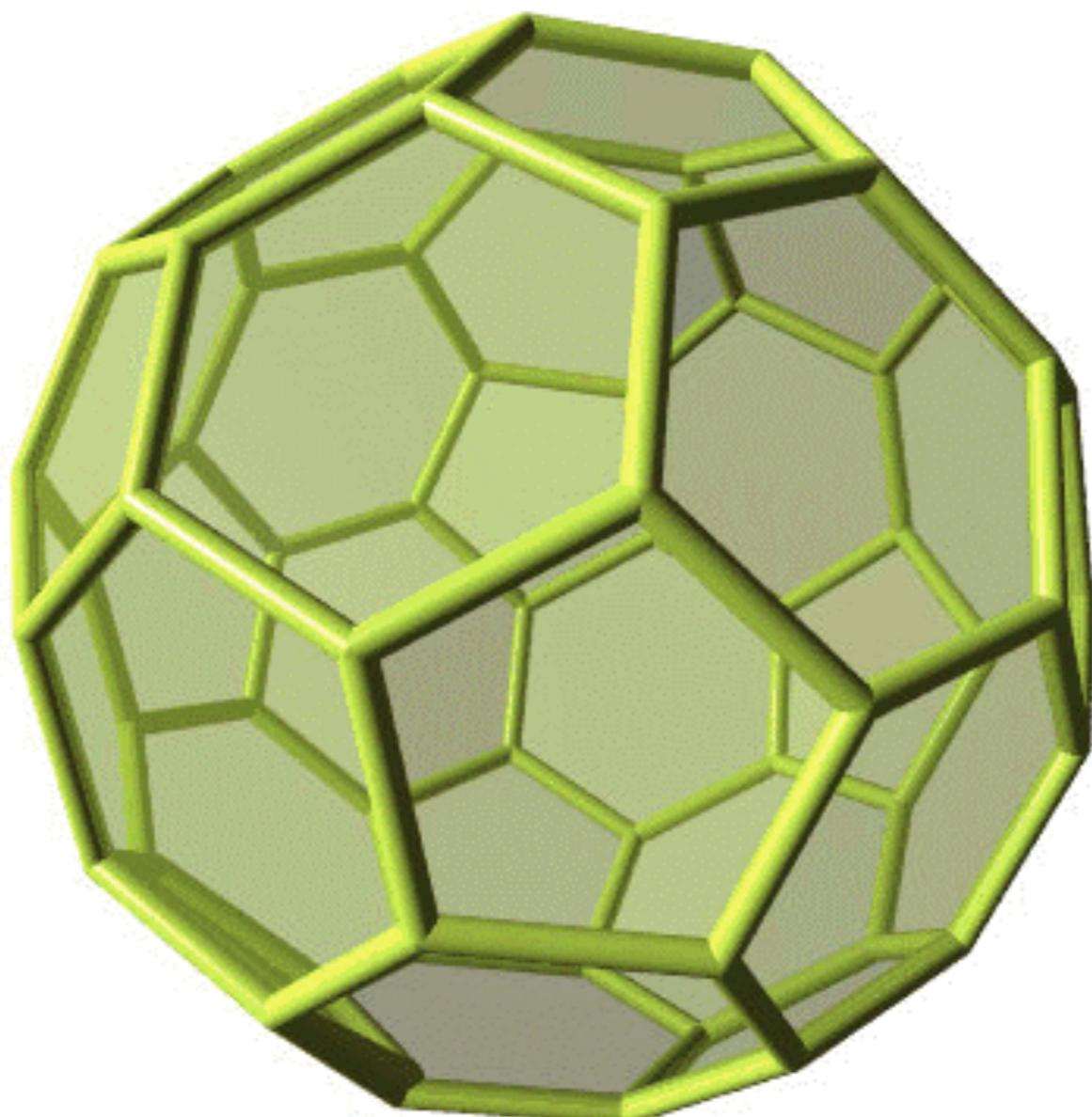
$$E = 90$$

$$V = 60$$

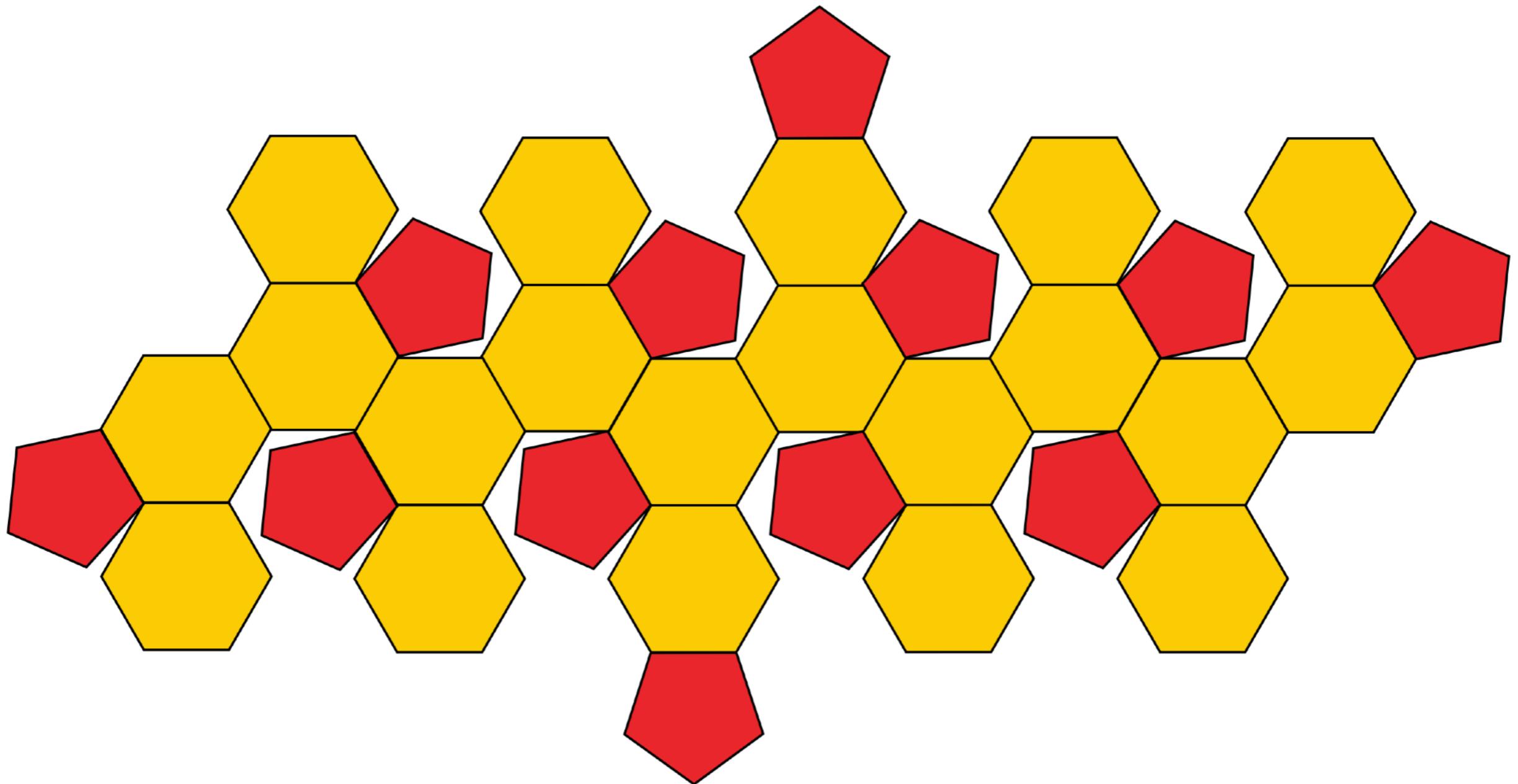


De Divina Proportione

Luca Pacioli (ca. 1445-1517)



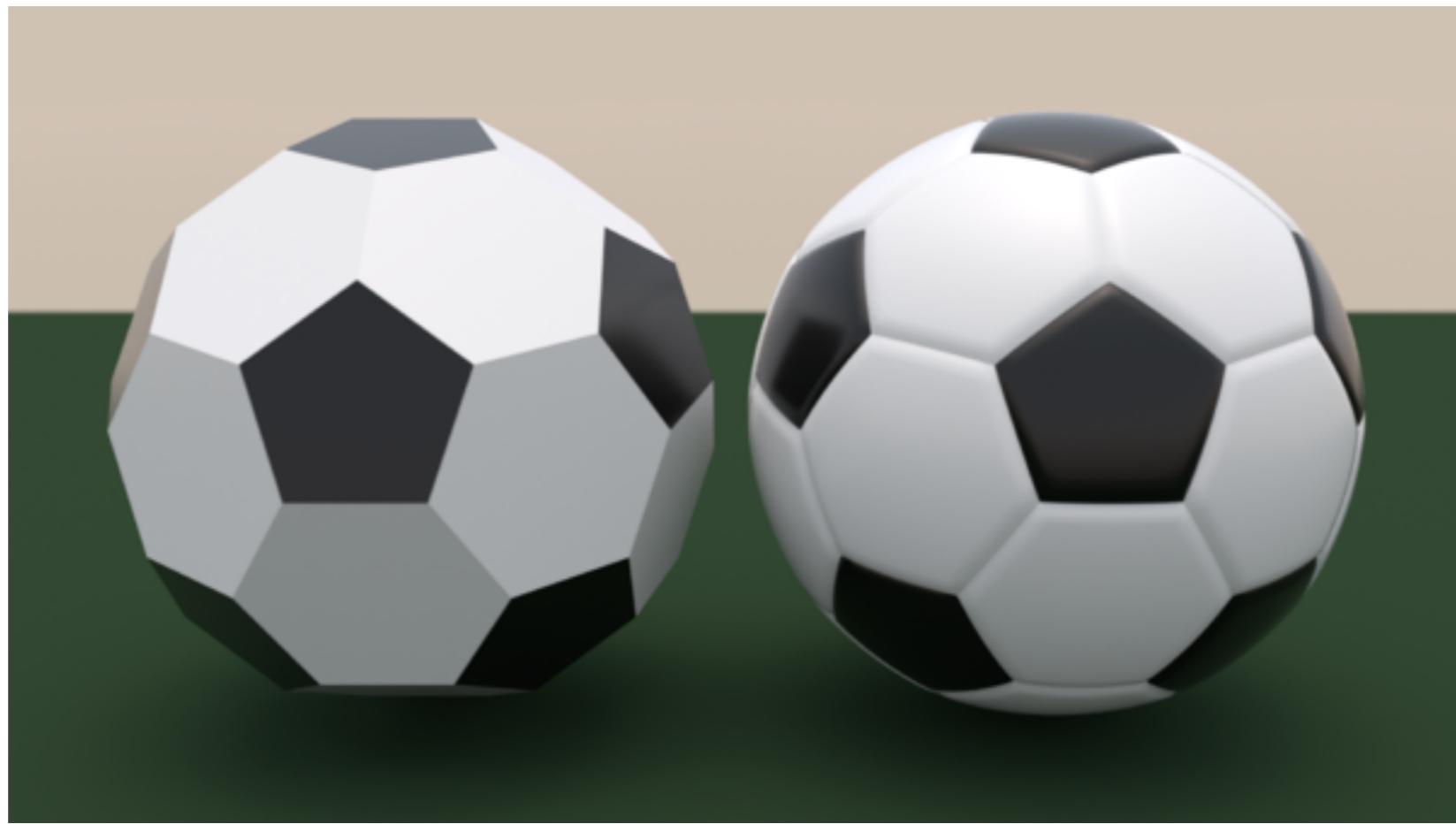
© Friedrich A. Lohmüller, 2013



G(1,1)



© Friedrich A. Lohmüller, 2013



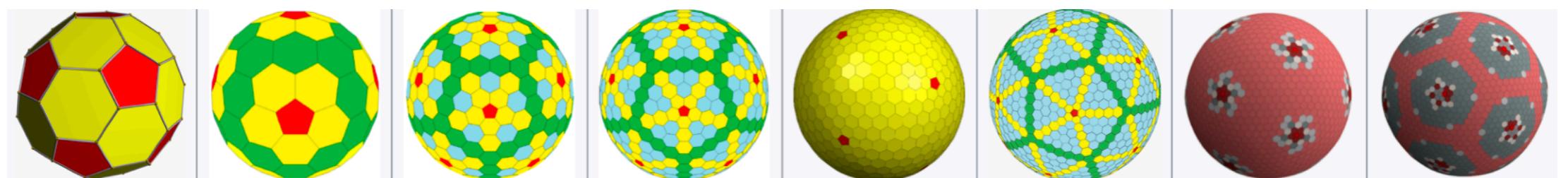
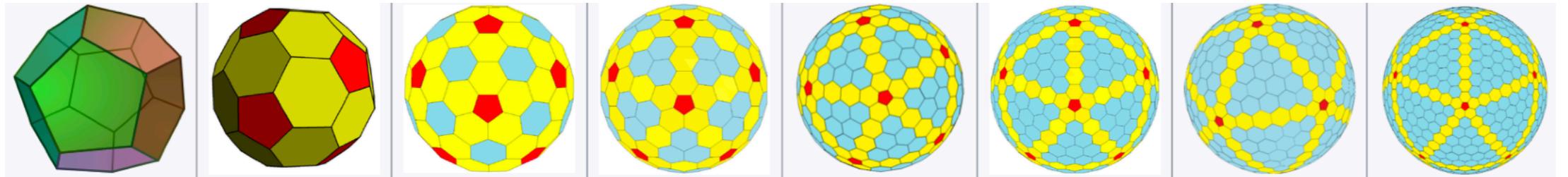


Polihedros de Goldberg (1937)

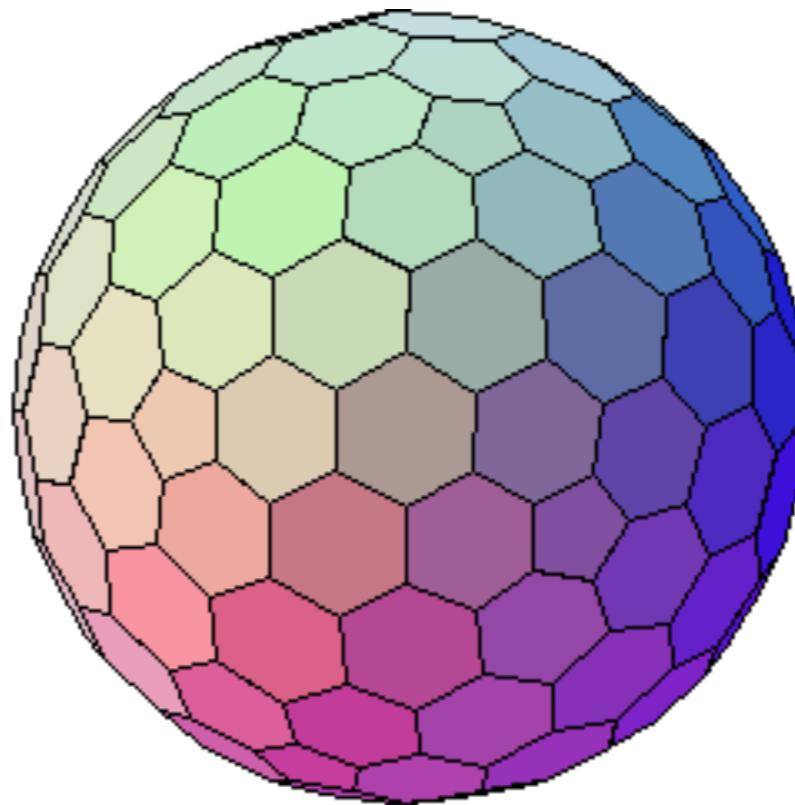
Cara: pentagono or hexagono

Exactamente tres caras se tocan en cada vértice

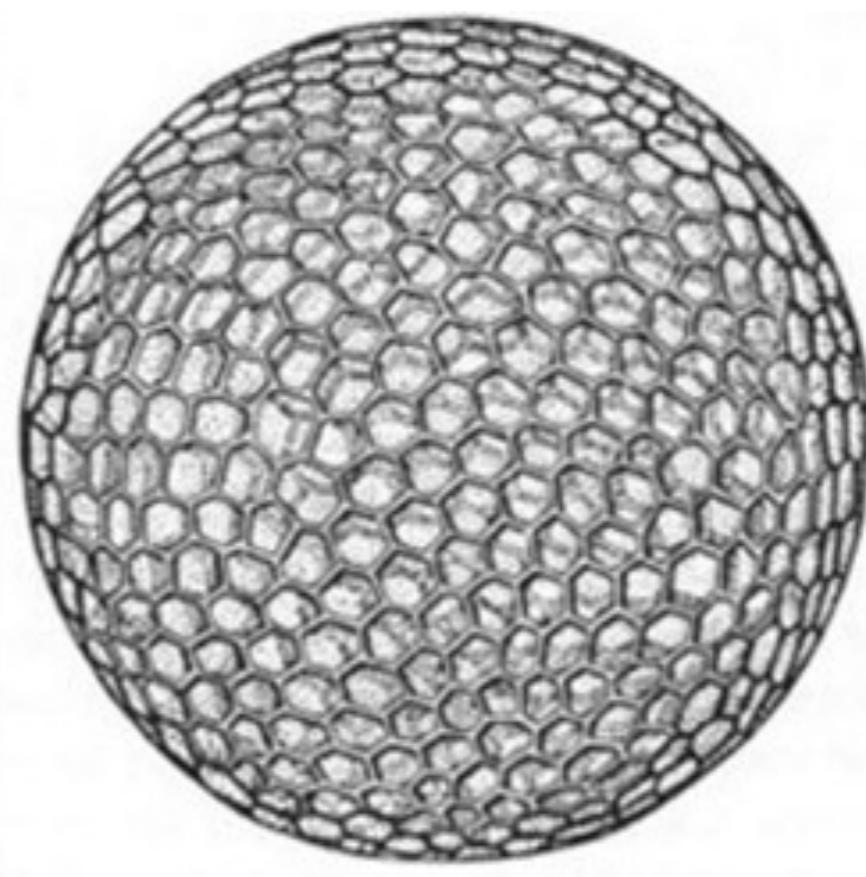
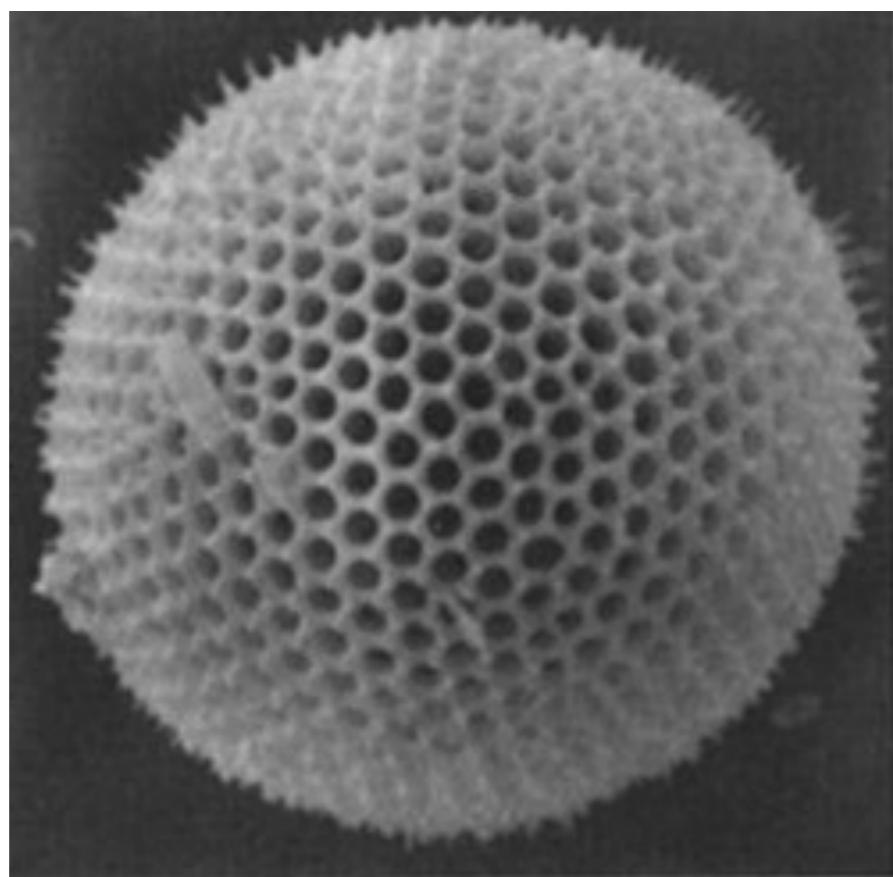
Tienen simetría rotacional



Polihedros de Goldberg



G(3,1)



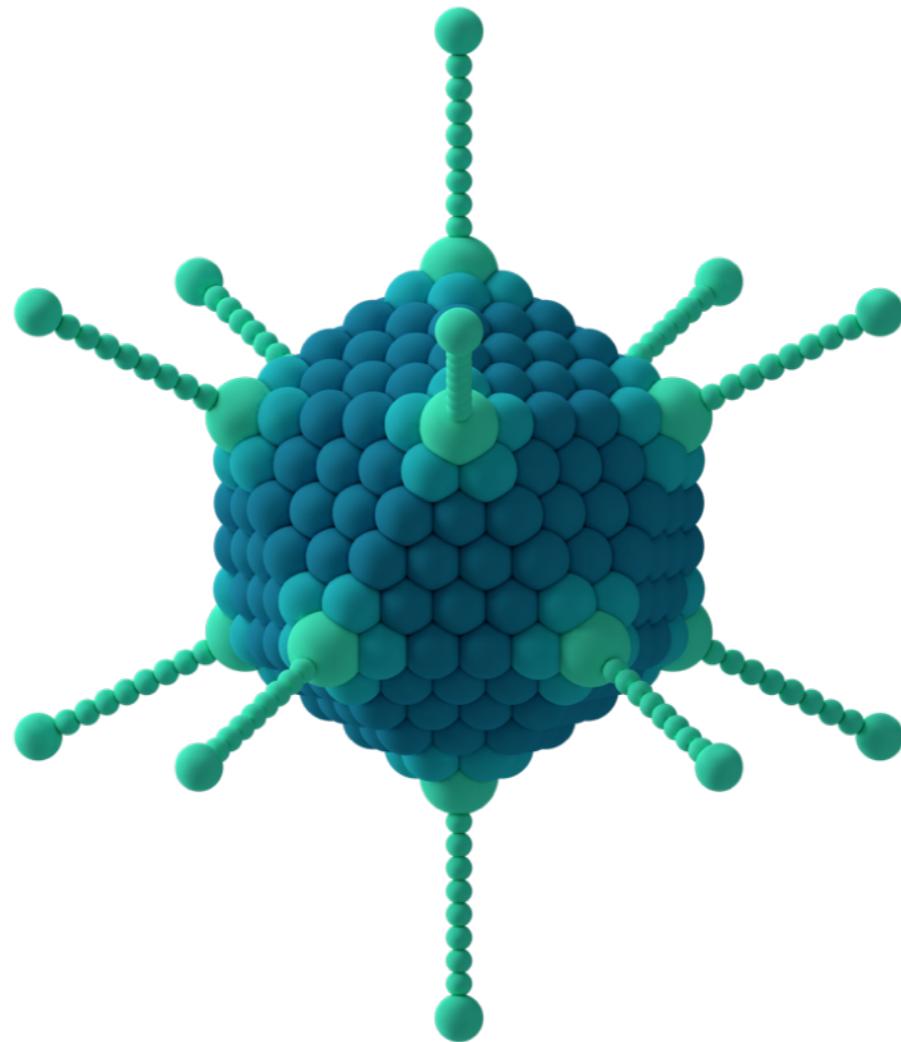
Aulonia Hexagona



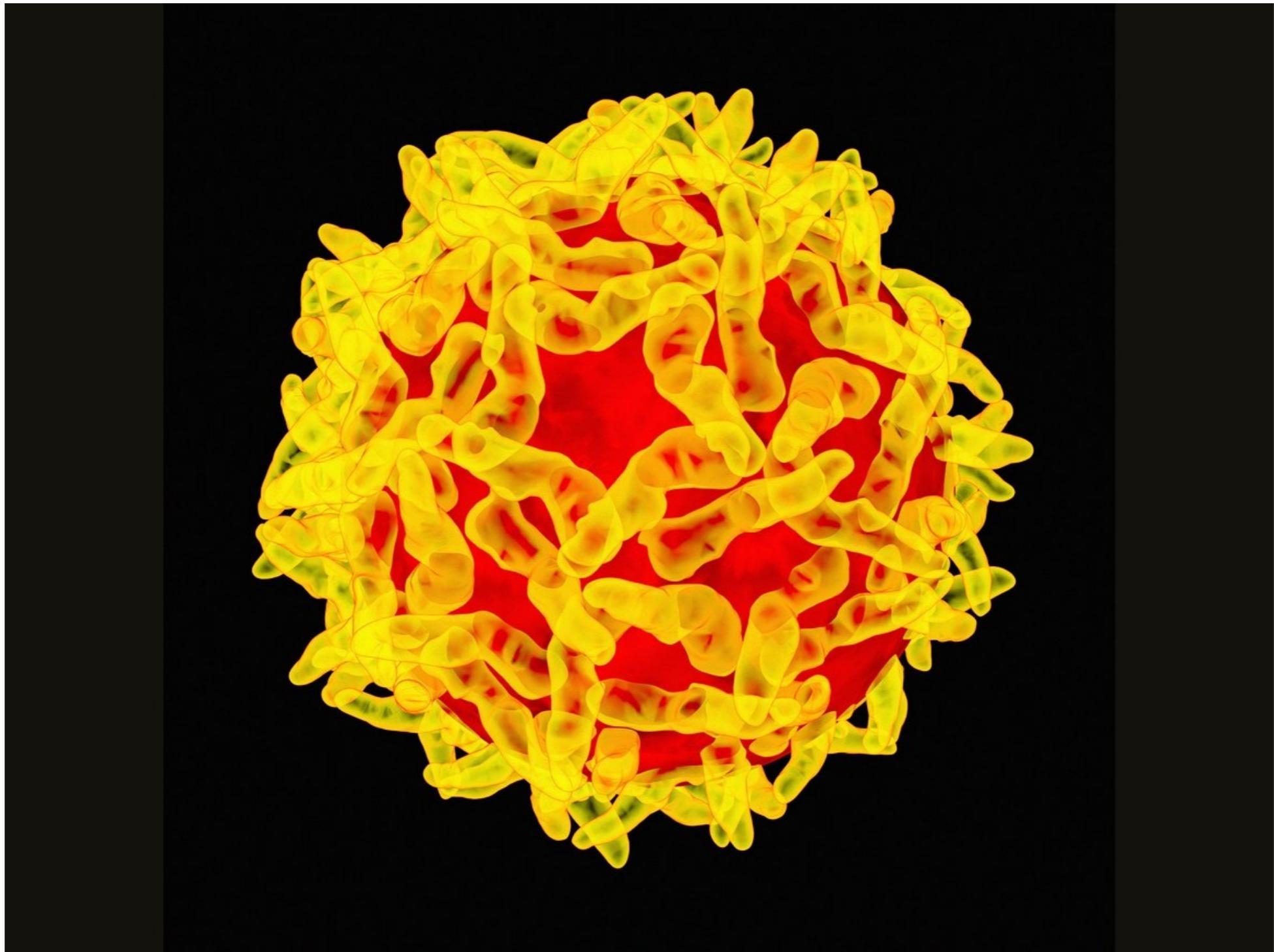


Virus icosahedrales

D. L. D. Caspar and A. Klug (1962)



Adenovirus



Yellow fever virus

