

# Raio das partículas e fótons

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José Luís Pereira Rebelo Fernandes

E-mail. [rebelofernandes@sapo.pt](mailto:rebelofernandes@sapo.pt)

## Introdução

Quando pensamos na dimensão de uma partícula deveremos pensar no modelo de equilíbrio da interacção da partícula com o universo envolvente.

A densidade de energia potencial universal vai exercer tracção sobre a partícula pelo que haverá da parte desta uma reacção em igual valor mas de sentido contrário.

Esta reacção implica que a energia da partícula tem forçosamente a tendência de se contrair, e se assim não fosse ela dissolver-se-ia no universo.

Se a partícula tem tendência a contrair-se, então terá uma natureza elástica, ou seja a sua massa/energia possuirá um módulo de elasticidade contractivo.

## Condição base de equilíbrio.

Para que a partícula esteja em equilíbrio, então a densidade de energia contractiva no limite interior da sua superfície, terá que ser igual à densidade de energia potencial universal na sua superfície exterior.

## A energia contractiva da matéria

Se admitimos que a matéria tem um módulo de elasticidade  $K'$ , então a sua energia contractiva deverá ser função da sua massa e do seu volume:

$$E_c = K m \left( \frac{4}{3} \pi r^3 \right)$$

Então, a sua densidade superficial de energia contractiva virá dada por:

$$U_c = \frac{K m \left( \frac{4}{3} \pi r^3 \right)}{4 \pi r^2}$$

$$U_c = K m \frac{1}{3} r$$

Sendo:

$\rho_u$  – Densidade de energia potencial de todas as outras massas universais (Com a exclusão da partícula em causa).

$\rho_m$  - Densidade de energia potencial da própria partícula na sua superfície.

$\rho'_u$  - Densidade superficial da energia potencial universal na partícula.

$$\rho'_u = \rho_u + \rho_m$$

$$U_c = \rho'_u$$

$$K m \frac{1}{3} r = \rho_u + \rho_m$$

**Qual o valor de K?**

Imaginemos a ausência de todas as outras massas universais. A densidade de energia potencial universal que iríamos encontrar seria a da própria partícula.

$$\rho_u = 0$$

$$\rho'_u = \frac{m_o}{r_o}$$

$$\frac{1}{3} K m_o r_o = \frac{m_o}{r_o}$$

$$K = \frac{3}{r_o^2}$$

Independentemente da massa da partícula, todas as partículas nas condições agora apresentadas, com a densidade de energia potencial universal tender para zero, tenderão para o mesmo raio independentemente da sua massa.

Genericamente teremos:

$$\frac{m r}{r_o^2} = \frac{m}{r}$$

$$r^2 = r_o^2$$

$$r = r_0$$

Podemos então dizer que no limite de ausência de massas universais, caso as massas se encontrem muito afastadas e a densidade de energia potencial gerada por elas venha a tender para zero, podemos imaginar que todas as massas independentemente da sua quantidade tenderão para o mesmo raio  $r_0$ .

Se olharmos para o Big-Bang, em que não existia qualquer massa exterior a este, poderemos afirmar que toda a massa universal estaria contida em  $r_0$ .

### **O equilíbrio entre a força elástica da partícula e a tracção universal, será:**

$$K m \frac{1}{3} r = \rho_u + \frac{m}{r}$$

$$\frac{3}{r_0^2} m \frac{1}{3} r = \rho_u + \frac{m}{r}$$

$$\frac{m r}{r_0^2} = \rho_u + \frac{m}{r}$$

### **Impacto da medição do raio do protão.**

Segundo as últimas notícias foi possível medir o raio do protão e com base nesta nova informação que conseguimos calcular o valor de  $R_0$  a constante elástica da matéria:

$$R_{protão} = 8,4184E-16 \text{ m}$$

Tendo em conta massa e o raio do protão, podemos desenvolver numericamente a teoria apresentada:

$$M_{protão} = 1,6726231E-27 \text{ m}$$

$$r_0^2 = \frac{m r}{\rho_u + \frac{m}{r}}$$

$$r_0 = \sqrt{\frac{m r}{\rho_u + \frac{m}{r}}}$$

Considerando os valores do protão:

$$r_0 = 4,5725205E - 35 \text{ m}$$

### Qual é a particular com a maior massa possível?

Agora já sabemos que o raio da particular depende da sua massa. A maior massa possível de <uma particular é aquela que se encontra no limite da transformação da partícula em buraco-negro.

$$C^2 = \frac{2 G m}{r}$$

$$\frac{m}{r} = \frac{C^2}{2 G}$$

$$\frac{m}{r} = \rho_u$$

$$m = r \rho_u$$

$$\frac{r \rho_u r}{r_o^2} = \rho_u + \rho_u$$

$$\frac{\rho_u r^2}{r_o^2} = 2 \rho_u$$

$$r^2 = 2 r_o^2$$

$$r = \sqrt{2} r_o$$

$$r = 6,4665205E - 35 \text{ m}$$

$$m = \frac{2 \rho_u r_o^2}{r}$$

$$m = 4,3549882E-08 \text{ Kg}$$

**Em termos gerais e concretos, teremos:**

$$K m r = \rho_u + \rho_m$$

$$K m r = \rho_u + \frac{m}{r}$$

$$\frac{m r}{r_o^2} = \rho_u + \frac{m}{r}$$

$$\frac{m}{r_o^2} r^2 - \rho_u r - m = 0$$

$$r = \frac{\rho_u + \sqrt{\rho_u^2 + 4 \frac{m^2}{r_0^2}}}{2 \frac{m}{r_0^2}}$$

### Generalização para todas as partículas.

A expressão que encontramos para o raio dos fotões, pelo princípio da definição de massa  $mC^2$ , deverá aplicar-se a qualquer partícula, mesmo em repouso

	m	eV	Raio
Neutrão	1,6749286E-27	939565635,5	8,4068123E-16
Protão	1,6726231E-27	938272345,4	8,4184000E-16
Electrão	9,1093897E-31	510999,0672	1,5457468E-12

### Comportamento das partículas/fotões em referencial com densidade de energia potencial universal diferente da do nosso local.

Vamos agora analisar o comportamento das partículas/fotões sujeitos a uma densidade de energia potencial diferente do nosso local Terra.

$\rho_l$  - Densidade de energia potencial noutra referencial.

$$\rho_l = A \rho_u$$

$$r = k (A\rho_u + \rho_{fA})$$

Resolvendo a equação de r:

$$\frac{r_l}{r} = \frac{k (A\rho_u + \rho_{fA})}{k (\rho_u + \rho_f)}$$

$$\frac{r_l}{r} = \frac{(A\rho_u + \rho_{fA})}{(\rho_u + \rho_f)}$$

$$\frac{r_l}{r} = A + \frac{\rho_f A}{A \rho_u} - \frac{A \rho_f}{\rho_u} + \dots$$

$$\frac{\rho_f A}{A \rho_u} = \sim 0$$

$$- \frac{A \rho_f}{\rho_u} = \sim 0$$

$$\frac{r_l}{r} = \sim A$$

O raio varia praticamente na proporção da densidade de energia potencial no local.

Com apoio de meios informáticos para um fóton de 1E24 eV.:

Densidade de energia potencial d/do	Raio do fóton m	R/Ro	Diferencial da velocidade relativa a C m/s	dV/dVo %
0,5	3,94938E-31	0,50000	2,009	400,00%
1	7,89875E-31	1	0,502	0,00%
2	1,57975E-30	2,00000	0,126	25,00%

O raio do fóton varia praticamente na proporção da densidade de energia potencial do meio em que se desloca.

O fóton em meio com menor densidade de energia potencial vai se deslocar mais devagar.

Como a densidade de potencial no local Terra vai diminuir no futuro, então o raio do fóton vai diminuir, assim como a sua velocidade de deslocamento.

## Resumo

- Os fótons de baixa energia movem-se praticamente à velocidade C, mas nunca a C.
- Os fótons de maior energia são os que apresentam maior desvio relativamente a C.

## Valores.

Estamos agora em condições para apresentar os valores respeitantes quer à velocidade de deslocamento dos fótons tendo em atenção o desvio da sua velocidade relativamente a C, quer ao seu raio.

V – Velocidade do fóton.

$\rho_u$  – Densidade de energia potencial universal no local.

$\rho_m$  – Densidade de energia potencial gerada pelo fóton na sua superfície.

$$V = C \sqrt{\frac{\rho_u}{\rho_u + \rho_m}}$$

Energia do fóton eV	Massa do fóton m	n 1,275^n eV	Raio do fóton m	Velocidade do fóton m/s	n 1,275^n eV	Desvio da velocidade do fóton relativamente a C
1,000E+00	1,783E-36	1	7,9E-07	299792458,8	1	5,02403E-49
1,275E+00	2,273E-36	2	6,2E-07	299792458,8	2	8,16719E-49
1,626E+00	2,898E-36	3	4,86E-07	299792458,8	3	1,32768E-48
2,073E+00	3,695E-36	4	3,81E-07	299792458,8	4	2,15831E-48
2,643E+00	4,711E-36	5	2,99E-07	299792458,8	5	3,5086E-48
3,369E+00	6,006E-36	6	2,34E-07	299792458,8	6	5,70367E-48
4,296E+00	7,658E-36	7	1,84E-07	299792458,8	7	9,27202E-48
5,477E+00	9,764E-36	8	1,44E-07	299792458,8	8	1,50728E-47
6,984E+00	1,245E-35	9	1,13E-07	299792458,8	9	2,45028E-47
8,904E+00	1,587E-35	10	8,87E-08	299792458,8	10	3,98323E-47
1,135E+01	2,024E-35	11	6,96E-08	299792458,8	11	6,47524E-47
1,447E+01	2,58E-35	12	5,46E-08	299792458,8	12	1,05263E-46
1,846E+01	3,29E-35	13	4,28E-08	299792458,8	13	1,71118E-46
2,353E+01	4,195E-35	14	3,36E-08	299792458,8	14	2,78174E-46
3,000E+01	5,348E-35	15	2,63E-08	299792458,8	15	4,52207E-46
3,825E+01	6,819E-35	16	2,06E-08	299792458,8	16	7,35119E-46
4,877E+01	8,694E-35	17	1,62E-08	299792458,8	17	1,19503E-45
6,218E+01	1,109E-34	18	1,27E-08	299792458,8	18	1,94267E-45
7,928E+01	1,413E-34	19	9,96E-09	299792458,8	19	3,15805E-45

1,011E+02	1,802E-34	20	7,81E-09	299792458,8	20	5,1338E-45
1,289E+02	2,298E-34	21	6,13E-09	299792458,8	21	8,34564E-45
1,643E+02	2,929E-34	22	4,81E-09	299792458,8	22	1,35669E-44
2,095E+02	3,735E-34	23	3,77E-09	299792458,8	23	2,20547E-44
2,671E+02	4,762E-34	24	2,96E-09	299792458,8	24	3,58526E-44
3,406E+02	6,072E-34	25	2,32E-09	299792458,8	25	5,82829E-44
4,343E+02	7,741E-34	26	1,82E-09	299792458,8	26	9,47461E-44
5,537E+02	9,87E-34	27	1,43E-09	299792458,8	27	1,54022E-43
7,060E+02	1,258E-33	28	1,12E-09	299792458,8	28	2,50382E-43
9,001E+02	1,605E-33	29	8,78E-10	299792458,8	29	4,07026E-43
1,148E+03	2,046E-33	30	6,88E-10	299792458,8	30	6,61672E-43
1,463E+03	2,608E-33	31	5,4E-10	299792458,8	31	1,07563E-42
1,866E+03	3,326E-33	32	4,23E-10	299792458,8	32	1,74857E-42
2,379E+03	4,24E-33	33	3,32E-10	299792458,8	33	2,84252E-42
3,033E+03	5,406E-33	34	2,6E-10	299792458,8	34	4,62088E-42
3,867E+03	6,893E-33	35	2,04E-10	299792458,8	35	7,51181E-42
4,930E+03	8,789E-33	36	1,6E-10	299792458,8	36	1,22114E-41
6,286E+03	1,121E-32	37	1,26E-10	299792458,8	37	1,98511E-41
8,015E+03	1,429E-32	38	9,86E-11	299792458,8	38	3,22705E-41
1,022E+04	1,822E-32	39	7,73E-11	299792458,8	39	5,24598E-41
1,303E+04	2,323E-32	40	6,06E-11	299792458,8	40	8,52799E-41
1,661E+04	2,961E-32	41	4,76E-11	299792458,8	41	1,38633E-40
2,118E+04	3,776E-32	42	3,73E-11	299792458,8	42	2,25365E-40
2,700E+04	4,814E-32	43	2,93E-11	299792458,8	43	3,6636E-40
3,443E+04	6,138E-32	44	2,29E-11	299792458,8	44	5,95564E-40
4,390E+04	7,826E-32	45	1,8E-11	299792458,8	45	9,68163E-40
5,597E+04	9,978E-32	46	1,41E-11	299792458,8	46	1,57387E-39
7,136E+04	1,272E-31	47	1,11E-11	299792458,8	47	2,55852E-39
9,099E+04	1,622E-31	48	8,68E-12	299792458,8	48	4,1592E-39
1,160E+05	2,068E-31	49	6,81E-12	299792458,8	49	6,7613E-39
1,479E+05	2,637E-31	50	5,34E-12	299792458,8	50	1,09913E-38
1,886E+05	3,362E-31	51	4,19E-12	299792458,8	51	1,78678E-38

2,404E+05	4,286E-31	52	3,29E-12	299792458,8	52	2,90463E-38
3,066E+05	5,465E-31	53	2,58E-12	299792458,8	53	4,72184E-38
3,909E+05	6,968E-31	54	2,02E-12	299792458,8	54	7,67595E-38
4,984E+05	8,884E-31	55	1,58E-12	299792458,8	55	1,24782E-37
6,354E+05	1,133E-30	56	1,24E-12	299792458,8	56	2,02849E-37
8,102E+05	1,444E-30	57	9,75E-13	299792458,8	57	3,29756E-37
1,033E+06	1,841E-30	58	7,65E-13	299792458,8	58	5,3606E-37
1,317E+06	2,348E-30	59	6E-13	299792458,8	59	8,71432E-37
1,679E+06	2,993E-30	60	4,7E-13	299792458,8	60	1,41662E-36
2,141E+06	3,817E-30	61	3,69E-13	299792458,8	61	2,3029E-36
2,730E+06	4,866E-30	62	2,89E-13	299792458,8	62	3,74365E-36
3,480E+06	6,204E-30	63	2,27E-13	299792458,8	63	6,08577E-36
4,438E+06	7,911E-30	64	1,78E-13	299792458,8	64	9,89317E-36
5,658E+06	1,009E-29	65	1,4E-13	299792458,8	65	1,60826E-35
7,214E+06	1,286E-29	66	1,09E-13	299792458,8	66	2,61443E-35
9,198E+06	1,64E-29	67	8,59E-14	299792458,8	67	4,25008E-35
1,173E+07	2,091E-29	68	6,74E-14	299792458,8	68	6,90903E-35
1,495E+07	2,665E-29	69	5,28E-14	299792458,8	69	1,12315E-34
1,906E+07	3,398E-29	70	4,14E-14	299792458,8	70	1,82582E-34
2,431E+07	4,333E-29	71	3,25E-14	299792458,8	71	2,9681E-34
3,099E+07	5,524E-29	72	2,55E-14	299792458,8	72	4,82501E-34
3,951E+07	7,044E-29	73	2E-14	299792458,8	73	7,84366E-34
5,038E+07	8,981E-29	74	1,57E-14	299792458,8	74	1,27509E-33
6,423E+07	1,145E-28	75	1,23E-14	299792458,8	75	2,07281E-33
8,190E+07	1,46E-28	76	9,64E-15	299792458,8	76	3,36961E-33
1,044E+08	1,861E-28	77	7,56E-15	299792458,8	77	5,47773E-33
1,331E+08	2,373E-28	78	5,93E-15	299792458,8	78	8,90473E-33
1,697E+08	3,026E-28	79	4,65E-15	299792458,8	79	1,44758E-32
2,164E+08	3,858E-28	80	3,65E-15	299792458,8	80	2,35321E-32
2,759E+08	4,919E-28	81	2,86E-15	299792458,8	81	3,82544E-32
3,518E+08	6,272E-28	82	2,25E-15	299792458,8	82	6,21874E-32
4,486E+08	7,997E-28	83	1,76E-15	299792458,8	83	1,01093E-31

5,719E+08	1,02E-27	84	1,38E-15	299792458,8	84	1,6434E-31
7,292E+08	1,3E-27	85	1,08E-15	299792458,8	85	2,67155E-31
9,297E+08	1,657E-27	86	8,5E-16	299792458,8	86	4,34294E-31
1,185E+09	2,113E-27	87	6,66E-16	299792458,8	87	7,05999E-31
1,511E+09	2,694E-27	88	5,23E-16	299792458,8	88	1,14769E-30
1,927E+09	3,435E-27	89	4,1E-16	299792458,8	89	1,86571E-30
2,457E+09	4,38E-27	90	3,21E-16	299792458,8	90	3,03295E-30
3,133E+09	5,585E-27	91	2,52E-16	299792458,8	91	4,93044E-30
3,994E+09	7,12E-27	92	1,98E-16	299792458,8	92	8,01504E-30
5,093E+09	9,078E-27	93	1,55E-16	299792458,8	93	1,30295E-29
6,493E+09	1,157E-26	94	1,22E-16	299792458,8	94	2,1181E-29
8,279E+09	1,476E-26	95	9,54E-17	299792458,8	95	3,44324E-29
1,056E+10	1,882E-26	96	7,48E-17	299792458,8	96	5,59741E-29
1,346E+10	2,399E-26	97	5,87E-17	299792458,8	97	9,0993E-29
1,716E+10	3,059E-26	98	4,6E-17	299792458,8	98	1,4792E-28
2,188E+10	3,9E-26	99	3,61E-17	299792458,8	99	2,40463E-28
2,789E+10	4,973E-26	100	2,83E-17	299792458,8	100	3,90903E-28
3,556E+10	6,34E-26	101	2,22E-17	299792458,8	101	6,35461E-28
4,534E+10	8,083E-26	102	1,74E-17	299792458,8	102	1,03302E-27
5,781E+10	1,031E-25	103	1,37E-17	299792458,8	103	1,67931E-27
7,371E+10	1,314E-25	104	1,07E-17	299792458,8	104	2,72992E-27
9,399E+10	1,675E-25	105	8,4E-18	299792458,8	105	4,43783E-27
1,198E+11	2,136E-25	106	6,59E-18	299792458,8	106	7,21425E-27
1,528E+11	2,724E-25	107	5,17E-18	299792458,8	107	1,17277E-26
1,948E+11	3,473E-25	108	4,05E-18	299792458,8	108	1,90648E-26
2,484E+11	4,428E-25	109	3,18E-18	299792458,8	109	3,09922E-26
3,167E+11	5,645E-25	110	2,49E-18	299792458,8	110	5,03817E-26
4,038E+11	7,198E-25	111	1,96E-18	299792458,8	111	8,19017E-26
5,148E+11	9,177E-25	112	1,53E-18	299792458,8	112	1,33141E-25
6,564E+11	1,17E-24	113	1,2E-18	299792458,8	113	2,16438E-25
8,369E+11	1,492E-24	114	9,44E-19	299792458,8	114	3,51847E-25
1,067E+12	1,902E-24	115	7,4E-19	299792458,8	115	5,71972E-25

1,360E+12	2,425E-24	116	5,81E-19	299792458,8	116	9,29811E-25
1,735E+12	3,092E-24	117	4,55E-19	299792458,8	117	1,51152E-24
2,212E+12	3,942E-24	118	3,57E-19	299792458,8	118	2,45717E-24
2,820E+12	5,027E-24	119	2,8E-19	299792458,8	119	3,99444E-24
3,595E+12	6,409E-24	120	2,2E-19	299792458,8	120	6,49346E-24
4,584E+12	8,171E-24	121	1,72E-19	299792458,8	121	1,05559E-23
5,844E+12	1,042E-23	122	1,35E-19	299792458,8	122	1,716E-23
7,451E+12	1,328E-23	123	1,06E-19	299792458,8	123	2,78957E-23
9,501E+12	1,694E-23	124	8,31E-20	299792458,8	124	4,5348E-23
1,211E+13	2,159E-23	125	6,52E-20	299792458,8	125	7,37188E-23
1,544E+13	2,753E-23	126	5,11E-20	299792458,8	126	1,19839E-22
1,969E+13	3,51E-23	127	4,01E-20	299792458,8	127	1,94813E-22
2,511E+13	4,476E-23	128	3,15E-20	299792458,8	128	3,16694E-22
3,201E+13	5,707E-23	129	2,47E-20	299792458,8	129	5,14825E-22
4,081E+13	7,276E-23	130	1,94E-20	299792458,8	130	8,36912E-22
5,204E+13	9,277E-23	131	1,52E-20	299792458,8	131	1,36051E-21
6,635E+13	1,183E-22	132	1,19E-20	299792458,8	132	2,21167E-21
8,459E+13	1,508E-22	133	9,34E-21	299792458,8	133	3,59535E-21
1,079E+14	1,923E-22	134	7,32E-21	299792458,8	134	5,84469E-21
1,375E+14	2,452E-22	135	5,74E-21	299792458,8	135	9,50127E-21
1,753E+14	3,126E-22	136	4,5E-21	299792458,8	136	1,54455E-20
2,236E+14	3,985E-22	137	3,53E-21	299792458,8	137	2,51086E-20
2,850E+14	5,081E-22	138	2,77E-21	299792458,8	138	4,08172E-20
3,634E+14	6,479E-22	139	2,17E-21	299792458,8	139	6,63534E-20
4,634E+14	8,26E-22	140	1,7E-21	299792458,8	140	1,07866E-19
5,908E+14	1,053E-21	141	1,34E-21	299792458,8	141	1,75349E-19
7,532E+14	1,343E-21	142	1,05E-21	299792458,8	142	2,85052E-19
9,604E+14	1,712E-21	143	8,22E-22	299792458,8	143	4,63388E-19
1,224E+15	2,183E-21	144	6,45E-22	299792458,8	144	7,53295E-19
1,561E+15	2,783E-21	145	5,06E-22	299792458,8	145	1,22458E-18
1,991E+15	3,549E-21	146	3,97E-22	299792458,8	146	1,9907E-18
2,538E+15	4,524E-21	147	3,11E-22	299792458,8	147	3,23613E-18

3,236E+15	5,769E-21	148	2,44E-22	299792458,8	148	5,26074E-18
4,126E+15	7,355E-21	149	1,91E-22	299792458,8	149	8,55199E-18
5,260E+15	9,377E-21	150	1,5E-22	299792458,8	150	1,39023E-17
6,707E+15	1,196E-20	151	1,18E-22	299792458,8	151	2,26E-17
8,551E+15	1,524E-20	152	9,24E-23	299792458,8	152	3,67391E-17
1,090E+16	1,944E-20	153	7,24E-23	299792458,8	153	5,97239E-17
1,390E+16	2,478E-20	154	5,68E-23	299792458,8	154	9,70887E-17
1,772E+16	3,16E-20	155	4,46E-23	299792458,8	155	1,5783E-16
2,260E+16	4,029E-20	156	3,5E-23	299792458,8	156	2,56572E-16
2,881E+16	5,136E-20	157	2,74E-23	299792458,8	157	4,1709E-16
3,674E+16	6,549E-20	158	2,15E-23	299792458,8	158	6,78032E-16
4,684E+16	8,35E-20	159	1,69E-23	299792458,8	159	1,10223E-15
5,972E+16	1,065E-19	160	1,32E-23	299792458,8	160	1,79181E-15
7,614E+16	1,357E-19	161	1,04E-23	299792458,8	161	2,9128E-15
9,708E+16	1,731E-19	162	8,14E-24	299792458,8	162	4,73513E-15
1,238E+17	2,207E-19	163	6,38E-24	299792458,8	163	7,69754E-15
1,578E+17	2,813E-19	164	5E-24	299792458,8	164	1,25133E-14
2,012E+17	3,587E-19	165	3,93E-24	299792458,8	165	2,0342E-14
2,566E+17	4,574E-19	166	3,08E-24	299792458,8	166	3,30684E-14
3,271E+17	5,831E-19	167	2,41E-24	299792458,8	167	5,37568E-14
4,171E+17	7,435E-19	168	1,89E-24	299792458,8	168	8,73884E-14
5,318E+17	9,479E-19	169	1,49E-24	299792458,8	169	1,42061E-13
6,780E+17	1,209E-18	170	1,17E-24	299792458,8	170	2,30938E-13
8,644E+17	1,541E-18	171	9,14E-25	299792458,8	171	3,75418E-13
1,102E+18	1,965E-18	172	7,17E-25	299792458,8	172	6,10289E-13
1,405E+18	2,505E-18	173	5,62E-25	299792458,8	173	9,92101E-13
1,792E+18	3,194E-18	174	4,41E-25	299792458,8	174	1,61278E-12
2,284E+18	4,072E-18	175	3,46E-25	299792458,8	175	2,62178E-12
2,913E+18	5,192E-18	176	2,71E-25	299792458,8	176	4,26203E-12
3,714E+18	6,62E-18	177	2,13E-25	299792458,8	177	6,92847E-12
4,735E+18	8,441E-18	178	1,67E-25	299792458,8	178	1,12631E-11
6,037E+18	1,076E-17	179	1,31E-25	299792458,8	179	1,83096E-11

7,697E+18	1,372E-17	180	1,03E-25	299792458,8	180	2,97645E-11
9,814E+18	1,749E-17	181	8,05E-26	299792458,8	181	4,83859E-11
1,251E+19	2,231E-17	182	6,31E-26	299792458,8	182	7,86573E-11
1,595E+19	2,844E-17	183	4,95E-26	299792458,8	183	1,27867E-10
2,034E+19	3,626E-17	184	3,88E-26	299792458,8	184	2,07864E-10
2,593E+19	4,623E-17	185	3,05E-26	299792458,8	185	3,37909E-10
3,307E+19	5,895E-17	186	2,39E-26	299792458,8	186	5,49314E-10
4,216E+19	7,516E-17	187	1,87E-26	299792458,8	187	8,92979E-10
5,375E+19	9,582E-17	188	1,47E-26	299792458,8	188	1,45165E-09
6,854E+19	1,222E-16	189	1,15E-26	299792458,8	189	2,35984E-09
8,738E+19	1,558E-16	190	9,04E-27	299792458,8	190	3,83621E-09
1,114E+20	1,986E-16	191	7,09E-27	299792458,8	191	6,23624E-09
1,421E+20	2,532E-16	192	5,56E-27	299792458,8	192	1,01378E-08
1,811E+20	3,229E-16	193	4,36E-27	299792458,8	193	1,64802E-08
2,309E+20	4,117E-16	194	3,42E-27	299792458,8	194	2,67907E-08
2,944E+20	5,249E-16	195	2,68E-27	299792458,8	195	4,35516E-08
3,754E+20	6,692E-16	196	2,1E-27	299792458,8	196	5,96046E-08
4,786E+20	8,532E-16	197	1,65E-27	299792458,8	197	1,19209E-07
6,102E+20	1,088E-15	198	1,29E-27	299792458,8	198	1,78814E-07
7,781E+20	1,387E-15	199	1,02E-27	299792458,8	199	2,98023E-07
9,920E+20	1,768E-15	200	7,96E-28	299792458,8	200	4,76837E-07
1,265E+21	2,255E-15	201	6,24E-28	299792458,8	201	7,7486E-07
1,613E+21	2,875E-15	202	4,9E-28	299792458,8	202	1,3113E-06
2,056E+21	3,665E-15	203	3,84E-28	299792458,8	203	2,14577E-06
2,622E+21	4,673E-15	204	3,01E-28	299792458,8	204	3,45707E-06
3,343E+21	5,959E-15	205	2,36E-28	299792458,8	205	5,60284E-06
4,262E+21	7,597E-15	206	1,85E-28	299792458,8	206	9,11951E-06
5,434E+21	9,687E-15	207	1,45E-28	299792458,8	207	1,48416E-05
6,928E+21	1,235E-14	208	1,14E-28	299792458,8	208	2,41399E-05
8,833E+21	1,575E-14	209	8,94E-29	299792458,8	209	3,91603E-05
1,126E+22	2,008E-14	210	7,01E-29	299792458,8	210	6,37174E-05
1,436E+22	2,56E-14	211	5,5E-29	299792458,8	211	0,000103593

1,831E+22	3,264E-14	212	4,31E-29	299792458,8	212	0,000168383
2,334E+22	4,161E-14	213	3,38E-29	299792458,8	213	0,000273705
2,976E+22	5,306E-14	214	2,65E-29	299792458,8	214	0,000444949
3,795E+22	6,765E-14	215	2,08E-29	299792458,8	215	0,000723302
4,838E+22	8,625E-14	216	1,63E-29	299792458,8	216	0,00117588
6,169E+22	1,1E-13	217	1,28E-29	299792458,8	217	0,001911521
7,865E+22	1,402E-13	218	1E-29	299792458,8	218	0,003107429
1,003E+23	1,788E-13	219	7,88E-30	299792458,8	219	0,005051553
1,279E+23	2,279E-13	220	6,18E-30	299792458,8	220	0,008211911
1,630E+23	2,906E-13	221	4,85E-30	299792458,8	221	0,013349533
2,079E+23	3,705E-13	222	3,8E-30	299792458,8	222	0,021701336
2,650E+23	4,724E-13	223	2,98E-30	299792458,8	223	0,035278261
3,379E+23	6,023E-13	224	2,34E-30	299792458,7	224	0,057349205
4,308E+23	7,68E-13	225	1,83E-30	299792458,7	225	0,093228281
5,493E+23	9,792E-13	226	1,44E-30	299792458,6	226	0,151554286
7,003E+23	1,248E-12	227	1,13E-30	299792458,6	227	0,246370435
8,929E+23	1,592E-12	228	8,85E-31	299792458,4	228	0,40050596
1,138E+24	2,03E-12	229	6,94E-31	299792458,1	229	0,651072443
1,452E+24	2,588E-12	230	5,44E-31	299792457,7	230	1,058399677
1,851E+24	3,299E-12	231	4,27E-31	299792457,1	231	1,720560968
2,360E+24	4,207E-12	232	3,35E-31	299792456	232	2,796986938
3,009E+24	5,363E-12	233	2,63E-31	299792454,3	233	4,546851754
3,836E+24	6,838E-12	234	2,06E-31	299792451,4	234	7,391475677
4,891E+24	8,719E-12	235	1,62E-31	299792446,8	235	12,01576704
6,236E+24	1,112E-11	236	1,27E-31	299792439,3	236	19,53312951
7,951E+24	1,417E-11	237	9,93E-32	299792427	237	31,7535392
1,014E+25	1,807E-11	238	7,79E-32	299792407,2	238	51,61933517
1,292E+25	2,304E-11	239	6,11E-32	299792374,9	239	83,9136501
1,648E+25	2,938E-11	240	4,79E-32	299792322,4	240	136,4120439
2,101E+25	3,746E-11	241	3,76E-32	299792237	241	221,7546079
2,679E+25	4,776E-11	242	2,95E-32	299792098,3	242	360,4892506
3,416E+25	6,089E-11	243	2,31E-32	299791872,8	243	586,018795

4,355E+25	7,763E-11	244	1,81E-32	299791506,2	244	952,6427261
5,552E+25	9,898E-11	245	1,42E-32	299790910,2	245	1548,629056
7,079E+25	1,262E-10	246	1,12E-32	299789941,3	246	2517,461635
9,026E+25	1,609E-10	247	8,75E-33	299788366,4	247	4092,373323
1,151E+26	2,052E-10	248	6,86E-33	299785806,3	248	6652,465544
1,467E+26	2,616E-10	249	5,38E-33	299781644,9	249	10813,88889
1,871E+26	3,335E-10	250	4,22E-33	299774880,9	250	17577,9399
2,385E+26	4,252E-10	251	3,31E-33	299763887,3	251	28571,47097
3,041E+26	5,422E-10	252	2,6E-33	299746022	252	46436,8097
3,878E+26	6,913E-10	253	2,04E-33	299716995,5	253	75463,25616
4,944E+26	8,813E-10	254	1,6E-33	299669851,4	254	122607,4307
6,304E+26	1,124E-09	255	1,25E-33	299593323,2	255	199135,6054
8,037E+26	1,433E-09	256	9,85E-34	299469208,2	256	323250,647
1,025E+27	1,827E-09	257	7,74E-34	299268208	257	524250,7981
1,307E+27	2,329E-09	258	6,08E-34	298943456,6	258	849002,2472
1,666E+27	2,97E-09	259	4,79E-34	298420729,9	259	1371728,879
2,124E+27	3,786E-09	260	3,77E-34	297584349	260	2208109,823
2,708E+27	4,827E-09	261	2,99E-34	296258598	261	3533860,83
3,453E+27	6,155E-09	262	2,38E-34	294187233	262	5605225,776
4,402E+27	7,848E-09	263	1,9E-34	291019814,5	263	8772644,293
5,613E+27	1,001E-08	264	1,54E-34	286322952,6	264	13469506,21
7,156E+27	1,276E-08	265	1,27E-34	279640116,9	265	20152341,88
9,124E+27	1,627E-08	266	1,06E-34	270608880,5	266	29183578,3
1,163E+28	2,074E-08	267	9,09E-35	259100076	267	40692382,81
1,483E+28	2,644E-08	268	7,95E-35	245301736	268	54490722,77
1,891E+28	3,371E-08	269	7,12E-35	229690345,4	269	70102113,39
2,411E+28	4,298E-08	270	6,49E-35	212908447,4	270	86884011,41

A vermelho – Valores aproximados

Porto, 2/11/2011

José Luís Pereira Rebelo Fernandes