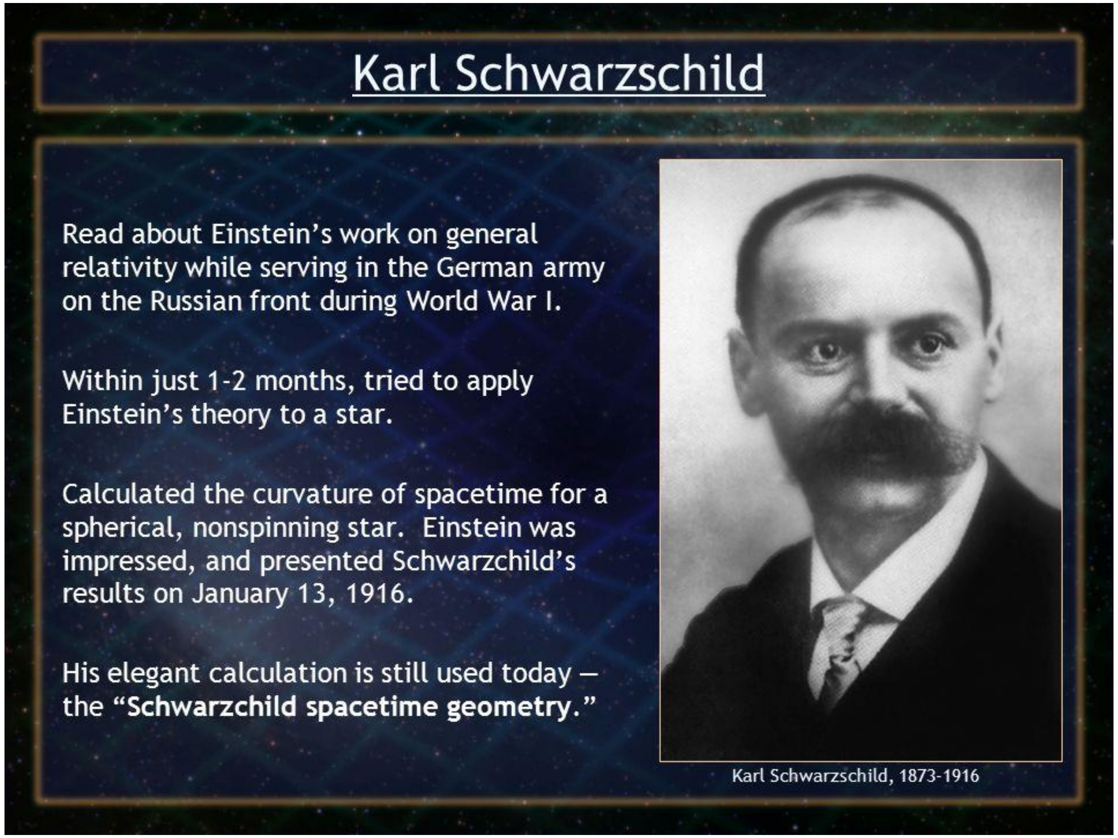
Although I (**HR**) initially thought I might have found something new,
the most part of what is shown below is not new,
although I found it without prior knowledge of other publications like

Pawel O Mazur and Emil Mottola 2015 *Class. Quantum Grav.* **32** 215024
https://iopscience.iop.org/article/10.1088/0264-9381/32/21/215024
https://arxiv.org/abs/1501.03806



2024-03-17

I have become convinced both black hole equations shown on next page are just plain **WRONG!**

They significantly differ from Schwarzschild's original publications!

Nevertheless, I'll leave this document as is.

http://henk-reints.nl/astro/HR-original-Schwarzschild-interior.pdf

http://henk-reints.nl/astro/HR-Schwarzschild-strict-grav-contr.pdf
http://henk-reints.nl/astro/HR-general-relativity-and-black-holes.pdf
http://henk-reints.nl/astro/HR-Deflection-of-light-passing-a-mass.pdf
http://henk-reints.nl/astro/HR-Deflected-light-stuff.pdf
http://henk-reints.nl/astro/HR-truly-black-Black-Hole.pdf

https://en.wikipedia.org/wiki/Interior_Schwarzschild_metric :

Exterior Schwarzschild solution:

$$ds^2 = \left(1 - \frac{r_S}{r}\right)^2 c^2 dt^2 - \left(1 - \frac{r_S}{r}\right)^{-1} dr^2 - r^2(d\theta^2 + \sin^2\theta\, d\varphi^2)$$

Interior Schwarzschild solution:

$$ds^2 = \frac{1}{4}\left(3\sqrt{1 - \frac{r_S}{r_g}} - \sqrt{1 - \frac{r^2 r_S}{r_g^3}}\right)^2 c^2 dt^2 - \left(1 - \frac{r^2 r_S}{r_g^3}\right)^{-1} dr^2 - r^2(d\theta^2 + \sin^2\theta\, d\varphi^2)$$

Both yield same for $r = r_g$, hence a continuous description of inside & outside of the thing.

The "g" confusingly means *geometrical*, not *gravitational*. We'll use "m" (*material*) instead.

Define:

$$\rho \coloneqq \frac{r}{r_S} \qquad \therefore r = \rho r_S$$

$$\rho_m \coloneqq \frac{r_m}{r_S} \qquad \therefore r_m = \rho_m r_S$$

$$\sigma \coloneqq \frac{s}{r_S} \qquad \tau \coloneqq \frac{ct}{r_S}$$

Then (interior):

$$\frac{ds^2}{\boldsymbol{r_S^2}} = \frac{1}{4}\left(3\sqrt{1 - \frac{r_S}{\rho_m r_S}} - \sqrt{1 - \frac{\rho^2 r_S^3}{\rho_m^3 r_S^3}}\right)^2 \frac{c^2 dt^2}{\boldsymbol{r_S^2}} - \left(1 - \frac{\rho^2 r_S^3}{\rho_m^3 r_S^3}\right)^{-1} \frac{dr^2}{\boldsymbol{r_S^2}} - \frac{\rho^2 r_S^2}{\boldsymbol{r_S^2}}(\cdots)$$

Yielding:

$$d\sigma^2 = \frac{1}{4}\left(3\sqrt{1-\frac{1}{\rho_m}} - \sqrt{1-\frac{\rho^2}{\rho_m^3}}\right)^2 d\tau^2 - \left(1-\frac{\rho^2}{\rho_m^3}\right)^{-1} d\rho^2 - \rho^2(d\theta^2 + \sin^2\theta\, d\varphi^2)$$

$\therefore \rho_m \geq 1$ ($\rho_m > 1 \rightarrow$ the thing is NOT a BH,

$\rho_m = 1 \rightarrow$ the thing IS a (critical) BH);

$(\boldsymbol{\rho} \leq \boldsymbol{\rho_m}) \rightarrow \mathbf{0}$ **apparently always possible; allows for dive into BH** $(\rho_m = 1)$ **!**

Substitute: $\frac{\rho^2}{\rho_m^3} =: \sin^2\eta \quad \therefore \sqrt{1-\frac{\rho^2}{\rho_m^3}} = \cos\eta \quad (0 \leq \eta \leq \frac{\pi}{2})$

$\frac{1}{\rho_m} =: \sin^2\eta_m \quad \therefore \sqrt{1-\frac{1}{\rho_m}} = \cos\eta_m \quad (0 \leq \eta_m \leq \frac{\pi}{2})$

Then:

$$d\sigma^2 = \left(\frac{3\cos\eta_m - \cos\eta}{2}\right)^2 d\tau^2 - \frac{d\rho^2}{\cos^2\eta} - \rho^2(d\theta^2 + \sin^2\theta\, d\varphi^2)$$

Density: $\Omega = \frac{3(M = r_S c^2/2G)}{4\pi r_m^3} = \frac{3c^2}{8\pi G r_S^2 \rho_m^3} = \frac{3}{\kappa r_S^2 \rho_m^3}$

Pressure[1]: $p_g = \Omega c^2 \frac{\cos\eta - \cos\eta_m}{3\cos\eta_m - \cos\eta}$

Resubstitution of η & η_m yields: $\boldsymbol{p_g = \Omega c^2 \frac{\sqrt{\rho_m^3 - \rho^2} - \sqrt{\rho_m^3 - \rho_m^2}}{3\cdot\sqrt{\rho_m^3 - \rho_m^2} - \sqrt{\rho_m^3 - \rho^2}}}$

Ωc^2 is the thing's interior *energy density* as far as *mass* is concerned.

1 kg/m³	Ωc^2	$\approx 8.99 \times 10^{16}$ J/m³
close-packed atomic hydrogen:	$\Omega c^2 \approx (1996$ kg/m³$)\cdot c^2$	$\approx 1.79 \times 10^{20}$ J/m³
solar core[2] ($p \approx 2.477 \times 10^{16}$ Pa):	Ωc^2	$\approx 1.46 \times 10^{22}$ J/m³

We have: $\Omega c^2 = \frac{3c^4}{8\pi G} \cdot \frac{1}{r_S^2} \cdot \frac{1}{\rho_m^3} = \frac{3c^8}{32\pi G^3} \cdot \frac{1}{M^2} \cdot \frac{1}{\rho_m^3}$

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1 https://en.wikipedia.org/wiki/Interior_Schwarzschild_metric#Pressure_and_stability
2 https://nssdc.gsfc.nasa.gov/planetary/factsheet/sunfact.html

$\frac{3c^4}{8\pi G} \approx 1.444636 \times 10^{43}$ N $\qquad$ $\frac{3c^8}{32\pi G^3} \approx 6.548923 \times 10^{96}$ kg³·m⁻¹·s⁻²

Min.BH[3]: $r_S \approx 10.75$ km $\therefore \frac{3c^4}{8\pi G} \cdot \frac{1}{r_S^2} \approx 1.25 \times 10^{35}$ Pa

Sirius B: $M \approx 1.018 M_\odot \Rightarrow r_S \approx 3.0065$ km, $r_m \approx 5850$ km $\Rightarrow \rho_m \approx 1946$
$p(\rho = 0) \approx 2.7883 \times 10^{22}$ Pa, Newtonian: $\sim 2.8 \times 10^{22}$ Pa.

If: $0 \le \rho \le \rho_m = 1$ (**inside** critical BH)

then: $\frac{\sqrt{1-\rho^2} - \sqrt{1-1}}{3 \cdot \sqrt{1-1} - \sqrt{1-\rho^2}} = \frac{\sqrt{1-\rho^2} - 0}{3 \cdot 0 - \sqrt{1-\rho^2}} = -1$

hence: $\boldsymbol{p_g = -\Omega c^2}$ **homogeneous** & **expansive**!

When $\rho_m = 1$ (i.e. $r_m = r_S$), the mass just forms a critical BH.

It has a homogeneous & **expansive** internal *pressure*.

Homogeneity $\Rightarrow$ ***NO* gravitation inside** this **BH**.

[3] http://henk-reints.nl/astro/HR-fall-into-black-hole-slides.pdf

We had: $$p_g = \Omega c^2 \frac{\sqrt{\rho_m^3-\rho^2} - \sqrt{\rho_m^3-\rho_m^2}}{3\cdot\sqrt{\rho_m^3-\rho_m^2} - \sqrt{\rho_m^3-\rho^2}}$$

Denominator equals zero if: $$\sqrt{9\rho_m^3 - 9\rho_m^2} = \sqrt{\rho_m^3 - \rho^2}$$

$$9\rho_m^3 - 9\rho_m^2 = \rho_m^3 - \rho^2$$
$$\rho^2 = \rho_m^3 - 9\rho_m^3 + 9\rho_m^2 = 9\rho_m^2 - 8\rho_m^3 = \rho_m^2(9 - 8\rho_m)$$

$$\rho = \rho_m\sqrt{9 - 8\rho_m} =: \boldsymbol{\rho_a \leq 1}$$ (vertical asymptote $\leq r_S$)

if $\rho_m > 9/8$: *pressure* always finite and positive (i.e. inward), all the way to $\rho = 0$; no pressure aymptote exists;

if $\rho_m = 9/8$: pressure asymptote appears at $\rho = 0$; i.e. $p_g \to +\infty$ if $\rho \to 0$;

if $\rho_m < 9/8$: negative *pressure* (i.e. outward, expansive) if $0 \leq \rho < \rho_a$; i.e. $p_g \to +\infty$ if $\rho \downarrow \rho_a$ and $p_g \to -\infty$ if $\rho \uparrow \rho_a$; it would be impossible for matter to escape outside $\rho = 1$, since a very high inward pressure would immediately arise outside the asymptote.

Define: $\varrho := \rho/\rho_m$

Newtonian gravitational pressure inside homogeneous sphere:

$$p_{g,\mathrm{N}} = \frac{3GM^2}{8\pi R^6}(R^2 - r^2)$$

$$= \frac{3G\left(\frac{c^2 r_S}{2G}\right)^2}{8\pi\rho_m^6 r_S^6}(\rho_m^2 r_S^2 - \rho^2 r_S^2) = \frac{3c^4 r_S^2}{4\cdot 8\pi G\rho_m^6 r_S^6}\rho_m^2 r_S^2\left(1 - \frac{\rho^2 r_S^2}{\rho_m^2 r_S^2}\right) = \frac{3c^4}{4\cdot 8\pi G\rho_m^4 r_S^2}(1-\varrho^2) = \frac{3c^2c^2}{8\pi G\rho_m^3 r_S^2}\cdot\frac{1-\varrho^2}{4\rho_m}$$

$$p_{g,\mathrm{N}} = \Omega c^2\cdot\frac{1-\varrho^2}{4\rho_m}$$

Schwarzschild:

$$\frac{\sqrt{\rho_m^3-\rho^2}-\sqrt{\rho_m^3-\rho_m^2}}{3\cdot\sqrt{\rho_m^3-\rho_m^2}-\sqrt{\rho_m^3-\rho^2}} = \frac{\sqrt{\rho_m^2(\rho_m-\varrho^2)}-\sqrt{\rho_m^2(\rho_m-1)}}{3\cdot\sqrt{\rho_m^2(\rho_m-1)}-\sqrt{\rho_m^2(\rho_m-\varrho^2)}}$$

$$p_{g,\mathrm{S}} = \Omega c^2\cdot\frac{\sqrt{\rho_m-\varrho^2}-\sqrt{\rho_m-1}}{3\cdot\sqrt{\rho_m-1}-\sqrt{\rho_m-\varrho^2}}$$

$$= \Omega c^2\cdot\frac{2\cdot\sqrt{(\rho_m-\varrho^2)(\rho_m-1)}-2\rho_m-\varrho^2+3}{8\rho_m+\varrho^2-9}$$

Please note:

all of the above is considered in the frame of a very distant observer:

Schwarzschild: Über das Gravitationsfeld eines Massenpunktes 191

$$ds^2 = F dt^2 - G(dx^2 + dy^2 + dz^2) - H(x dx + y dy + z dz)^2$$

wobei F, G, H Funktionen von $r = \sqrt{x^2 + y^2 + z^2}$ sind.

Die Forderung (4) verlangt: Für $r = \infty$: $F = G = 1$, $H = 0$.

In http://henk-reints.nl/astro/HR-fall-into-black-hole-slides.pdf

is derived that, as measured on the spot, the thing is gravitationally

contracted by $\gamma_{\mathrm{ff}} = \frac{1+2\rho}{2\rho}$, which for $\rho = 1$ yields $\gamma = \frac{3}{2}$,

hence the true radius of a BH must be $\frac{2}{3} r_S$,

which increases its density (hence pressure) by

$$\left(\frac{3}{2}\right)^3 = \frac{27}{8} = 3.375\,.$$

For a black hole, i.e. $\rho_m = 1$, we obtain: $p_{g,S} = -\Omega c^2$

The minus sign indicates it is expansive/repulsive. We now want to interpret it as a *thermal pressure* and then we must of course use its absolute value.

Ideal gas law: $T = \dfrac{pV}{N k_\mathrm{B}}$ (*IFF applicable*…)

and: $N = \dfrac{M}{m}$

so: $T_\mathrm{BH} = \dfrac{pVm}{M k_\mathrm{B}} = \dfrac{|p_{g,S}|m}{\Omega k_\mathrm{B}} = \dfrac{\Omega c^2 m}{\Omega k_\mathrm{B}} = \dfrac{mc^2}{k_\mathrm{B}}$

With the *neutron mass*, this yields:

$$T_\mathrm{BH} \approx 1.09 \times 10^{13}\ \mathrm{K} \approx 9 \cdot T_\mathrm{Hagedorn}\ ^{(4)} =$$ DAMN HOT!

as the *internal temperature* of a black hole.

[4] https://cerncourier.com/a/the-tale-of-the-hagedorn-temperature/ Fig. 2.: $T_\mathrm{H} = (158\ \mathrm{Mev}) \times 2/3k_\mathrm{B} = 1.22 \times 10^{12}$ K

Hocus pocus?

$$T_{\mathrm{BH}} = \frac{m_{\mathrm{n}} c^2}{k_{\mathrm{B}}}$$

yields: $\bar{E}_{\mathrm{th,BH}} = \frac{3}{2} k_{\mathrm{B}} T_{\mathrm{BH}} = \frac{3}{2} m_{\mathrm{n}} c^2$ (per molecule)

adding up to: $E_{\mathrm{th,BH}} = \frac{3}{2} M c^2 \Rightarrow M_{\mathrm{th}} = \frac{3}{2} M_{\mathrm{cold}}$

yielding: $M_{\mathrm{obs}} = M_{\mathrm{cold}} + M_{\mathrm{th}} = \frac{5}{2} M_{\mathrm{cold}}$

*Thermal energy **is** part of the energy-momentum tensor,*
*so it **does** contribute to the density, hence to the Schwarzschild radius!*

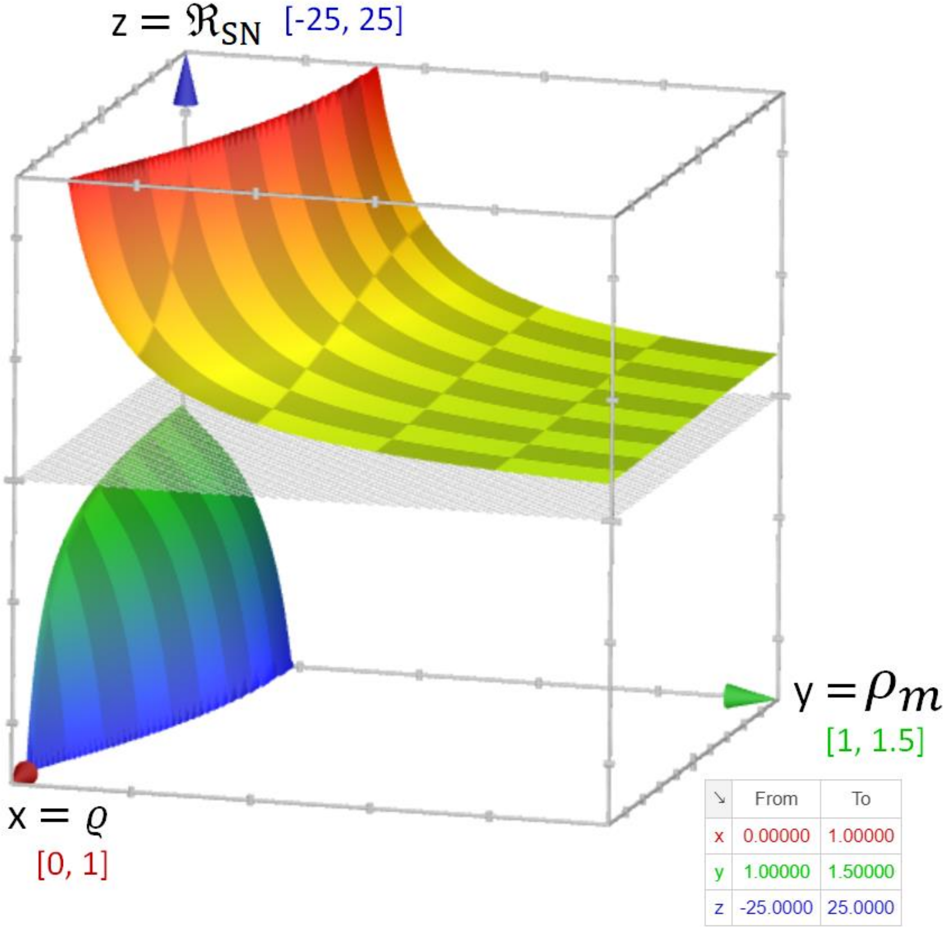
Easy calculation with an *effective molecular mass* of $\frac{2}{5} m_{\mathrm{n}}$

renders: $T_{\mathrm{BH}} = \frac{2}{5} \cdot \frac{m_{\mathrm{n}} c^2}{k_{\mathrm{B}}} \approx 4.36 \times 10^{12}$ K

which still is a factor of $6/5$ larger that what is derived in
http://henk-reints.nl/astro/HR-fall-into-black-hole-slides.pdf ($T_{\mathrm{bhc}} = m_{\mathrm{n}} c^2 / 3 k_{\mathrm{B}}$),
but I consider it in reasonable agreement since this is just one iteration step.

Schwarzschild/Newton ratio: $\Re_{\text{SN}} = \dfrac{4\rho_g\left(2\cdot\sqrt{(\rho_m-\varrho^2)(\rho_m-1)}-2\rho_m-\varrho^2+3\right)}{(1-\varrho^2)(8\rho_m+\varrho^2-9)}$

$\lim\limits_{\rho_m\to\infty}\Re_{\text{SN}} = 1$ i.e. the larger the sphere, the more Schwarzschild approaches Newton.



Did homo non satis sapiens make an ***implicit assumption***?

Don't take anything for granted if not supported by facts!

Which observed phenomenon can substantiate that gravitation (be it Newtonian or Einsteinian) **would penetrate the inside of baryons?**

What if it could pierce or curve empty space at most, i.e. only *between* & not *through* particles?

In very compact matter such as neutronium, it would have a (small) finite *penetration depth*, thus reducing *gravitational pressure* (to $p < p_{\mathrm{C},n}$?).

Wouldn't the *strong nuclear force* easily keep it together?

Sir Isaac Newton (PHILOSOPHIÆ NATURALIS PRINCIPIA MATHEMATICA, LIBER TERTIUS, REGULÆ PHILOSOPHANDI):

Natura enim ſimplex eſt & rerum cauſis ſuperfluis non luxuriat.

For nature is simple & does not benefit from superfluous causes of things.

We[5] had found:
$$\frac{p_{g,S}}{\Omega c^2} = \frac{\sqrt{\rho_m^3-\rho^2} - \sqrt{\rho_m^3-\rho_m^2}}{3\cdot\sqrt{\rho_m^3-\rho_m^2} - \sqrt{\rho_m^3-\rho^2}}$$

as well as:
$$\rho_a = \rho_m\sqrt{9-8\rho_m} \quad \text{(asymptote iff } \rho_m < \tfrac{9}{8}\text{)}$$

and we equate:
$$\rho = \rho_a + \varepsilon = \rho_m\sqrt{9-8\rho_m} + \varepsilon$$

where: ε is a small distance to the asymptote,
$\varepsilon < 0$ means inside it, $\varepsilon > 0$ is outside it.

It renders:
$$\frac{p_{g,S}}{\Omega c^2} = \frac{\sqrt{\rho_m^3-\left(\rho_m\sqrt{9-8\rho_m}+\varepsilon\right)^2} - \sqrt{\rho_m^3-\rho_m^2}}{3\cdot\sqrt{\rho_m^3-\rho_m^2} - \sqrt{\rho_m^3-\left(\rho_m\sqrt{9-8\rho_m}+\varepsilon\right)^2}}$$

or:
$$\frac{p_{g,S}}{\Omega c^2} = \frac{\sqrt{\rho_m-\left(\sqrt{9-8\rho_m}+\frac{\varepsilon}{\rho_m}\right)^2} - \sqrt{\rho_m-1}}{3\cdot\sqrt{\rho_m-1} - \sqrt{\rho_m-\left(\sqrt{9-8\rho_m}+\frac{\varepsilon}{\rho_m}\right)^2}}$$

which we evaluate numerically:

[5] That is: Karl Schwarzschild

Dimensionless pressure narrowly inside/outside asymptotic shell:

ρ_m \ ε	-0.05	-0.04	-0.03	-0.02	-0.01	0.00	0.01	0.02	0.03	0.04	0.05
1.01	-1.91	-2.08	-2.35	-2.90	-4.50	-|+	1.75	6.17e-2	n/a	n/a	n/a
1.02	-2.69	-3.03	-3.60	-4.72	-8.07	-|+	5.25	1.89	0.745	0.128	NaN
1.03	-3.55	-4.08	-4.97	-6.75	-12.1	-|+	9.17	3.84	2.06	1.15	0.593
1.04	-4.52	-5.28	-6.54	-9.07	-16.6	-|+	13.6	6.04	3.51	2.24	1.47
1.05	-5.64	-6.66	-8.36	-11.7	-21.9	-|+	18.7	8.58	5.18	3.48	2.46
1.06	-6.98	-8.30	-10.5	-14.9	-28.1	-|+	24.8	11.5	7.14	4.93	3.61
1.07	-8.61	-10.3	-13.1	-18.8	-35.7	-|+	32.1	15.1	9.49	6.67	4.98
1.08	-10.7	-12.8	-16.4	-23.6	-45.2	-|+	41.2	19.6	12.4	8.83	6.67
1.09	-13.5	-16.3	-20.9	-30.1	-57.9	-|+	53.3	25.5	16.3	11.7	8.89
1.10	-17.8	-21.4	-27.5	-39.8	-76.7	-|+	71.0	34.1	21.8	15.7	12.1
1.11	-25.6	-30.8	-39.6	-57.1	-110	-|+	102	48.9	31.4	22.6	17.4
1.12	-53.2	-62.7	-78.9	-112	-212	-|+	192	91.2	57.9	41.4	31.6

It seems obvious that, by absolute value,
the expansive pressure inside the asymptotic shell
exceeds the compressive pressure outside it.

Because $\boldsymbol{\rho_m = 1 \rightarrow p_g = -\Omega c^2}$ & $\left|\boldsymbol{p_{\mathbf{outw},\rho<\rho_a}}\right| > \left|\boldsymbol{p_{\mathbf{inw},\rho>\rho_a}}\right|$

it is plausible that, as observed by a distant observer, each and every black hole completely fills its entire Schwarzschild sphere and that it has a homogeneus & *expansive* internal pressure.

It is like a blown up balloon without internal gravity.

(2023-02-26: this is more recent than what I stated in http://henk-reints.nl/astro/HR-fall-into-black-hole-slides.pdf).

Conjecture by HR:

If $\rho_m < \frac{9}{8}$, i.e. if the thing grows such that $r_S > \frac{8}{9} r_m$,
it will collapse to $\rho_m = 1$ (i.e. $r_m = r_S$).

The asymptotic shell arising at $\rho_a = 0$ quickly grows to $\rho_a = 1$ since its expansive internal pressure exceeds the compressive outer pressure; the density increases by a factor of $(9/8)^3 \approx 1.424$, thus raising the int./ext. pressure difference by the same, speeding up the collapse even more.

This occurs only if the *density* is amply below that of neutronium.

For *densities* approaching neutronium, *gravity* becomes "increasingly weaker", thus terminating the validity of

$$G_{\mu\nu} = \kappa T_{\mu\nu} .$$

De brug van Breukelen

De brug bij Breukelen is kapot.
Hij brak ineens in tweeën
en niemand weet hoe 't verder mot.
't Is net een week gelejen.

Er waren ook véél te veel mensen op:
de boer met z'n karretje hop hop hop,
een stuk of wat fietsen, een stuk of wat brommers,
een man met tomaten, een man met komkommers,
de visboer met haring en schelvis en schar
en de ijscoman, met z'n ijscokar.

En 't stokoude mannetje van de negosie
met veters en lintjes en zeep in een doossie,
en een kalf en een stier en het lammetje mek
en een kat en een os met een touw om z'n nek
en een geit en een schaap en een kip en een rund
en dat had dan allemaal nog wel gekund...
want lieveling, dit was een ijzeren brug,
maar sakkerdejen! Daar kwam ook nog een mug!

Die brug was tot nu toe nog helemaal heel,
maar nou met die mug was het net iets te veel.
En zo kwam het dan dat van krikkerdekrak
de ijzeren brug in twee helften brak.

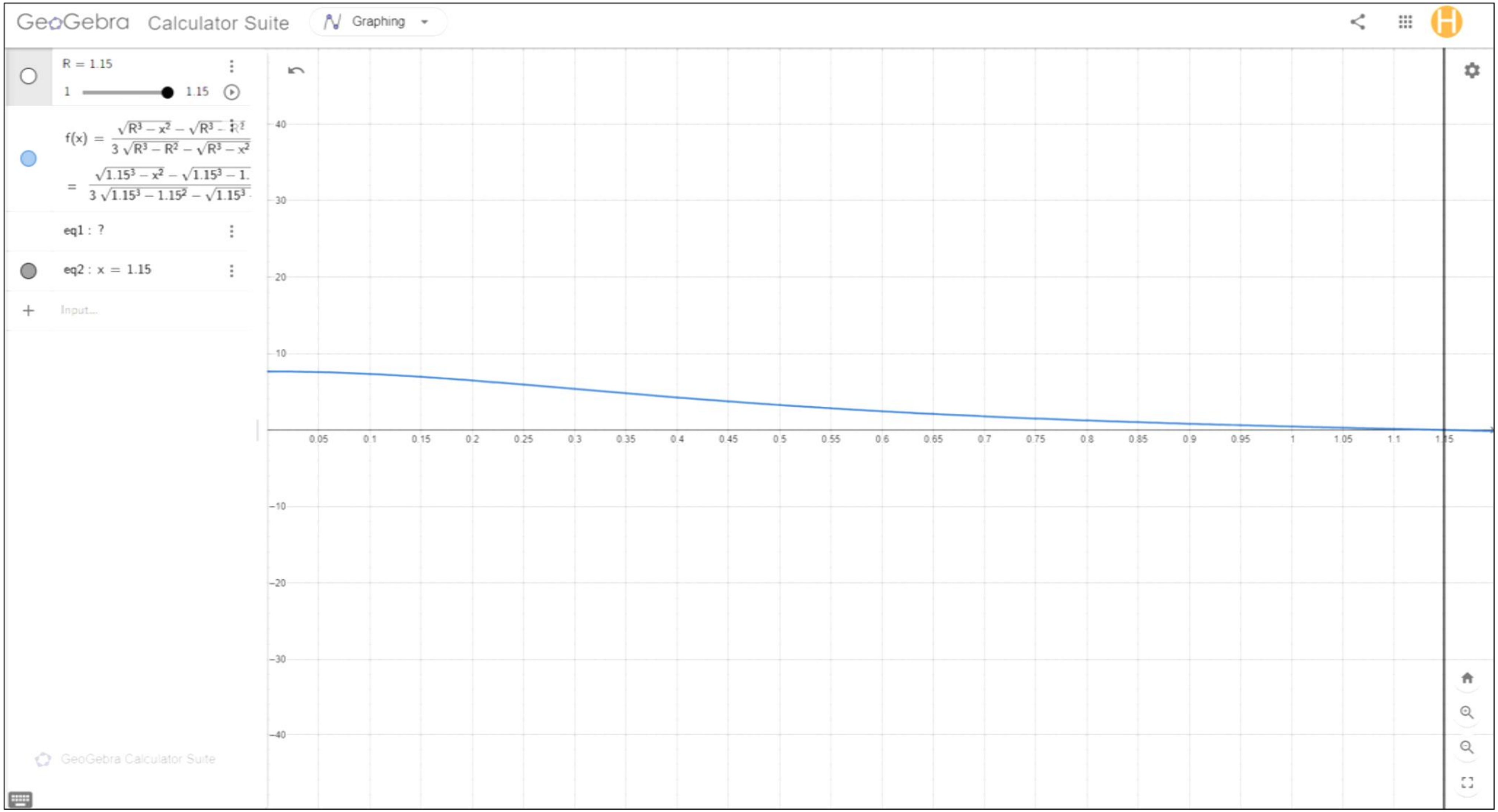
En is iedereen in het water gevallen?
Jazeker, jazeker! Van plons met z'n allen!
En zijn al die mensen dan toch nog gered?
Jazeker, jazeker! Nog net. Nog net!
En ook al die dieren, behalve de mug.
Die zagen ze helemaal nooit meer terug.

De brug bij Breukelen is kapot.
Hij brak ineens in tweeën
en niemand weet hoe 't verder mot.
Wie heeft er nog ideeën?

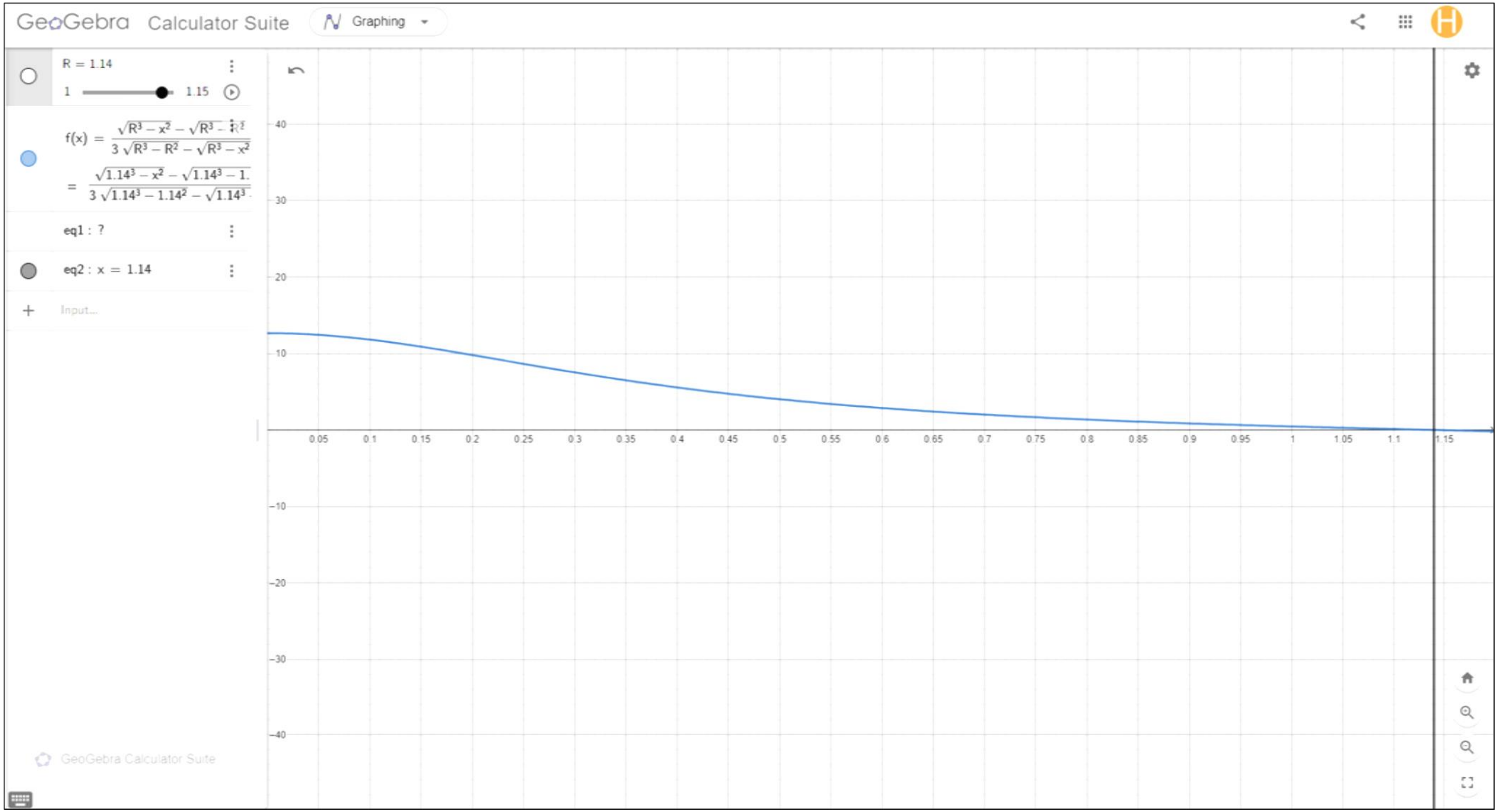
Annie M.G. Schmidt

Brooklyn bridge broke down.
There were way too many people on it with all their things, as well as loads of animals.
And then a mosquito landed...

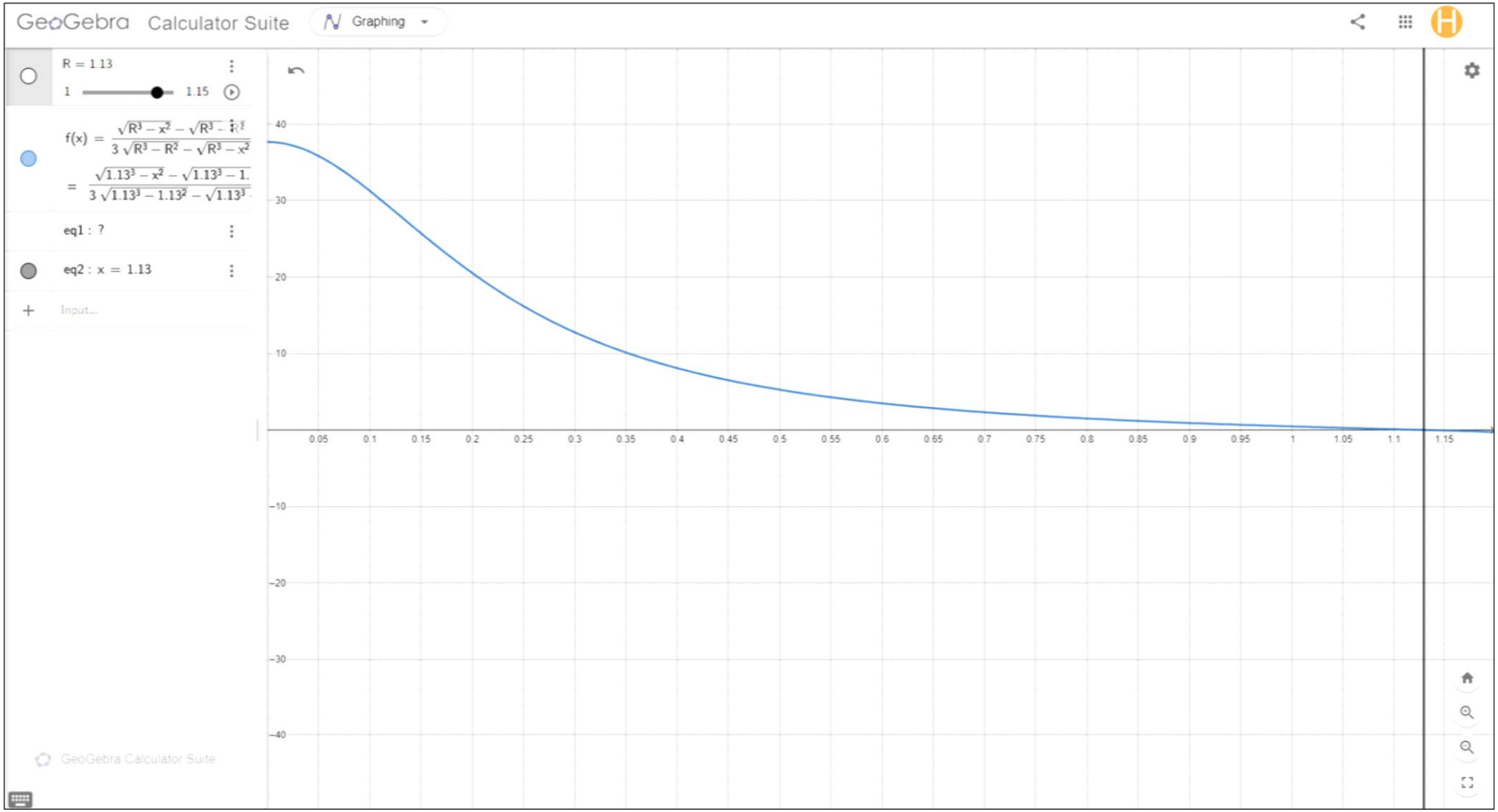
$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\quad 0\leq x=\rho\leq 1.15\,,\quad \mathrm{R}=\boldsymbol{\rho_m=1.15>\frac{9}{8}}:$$



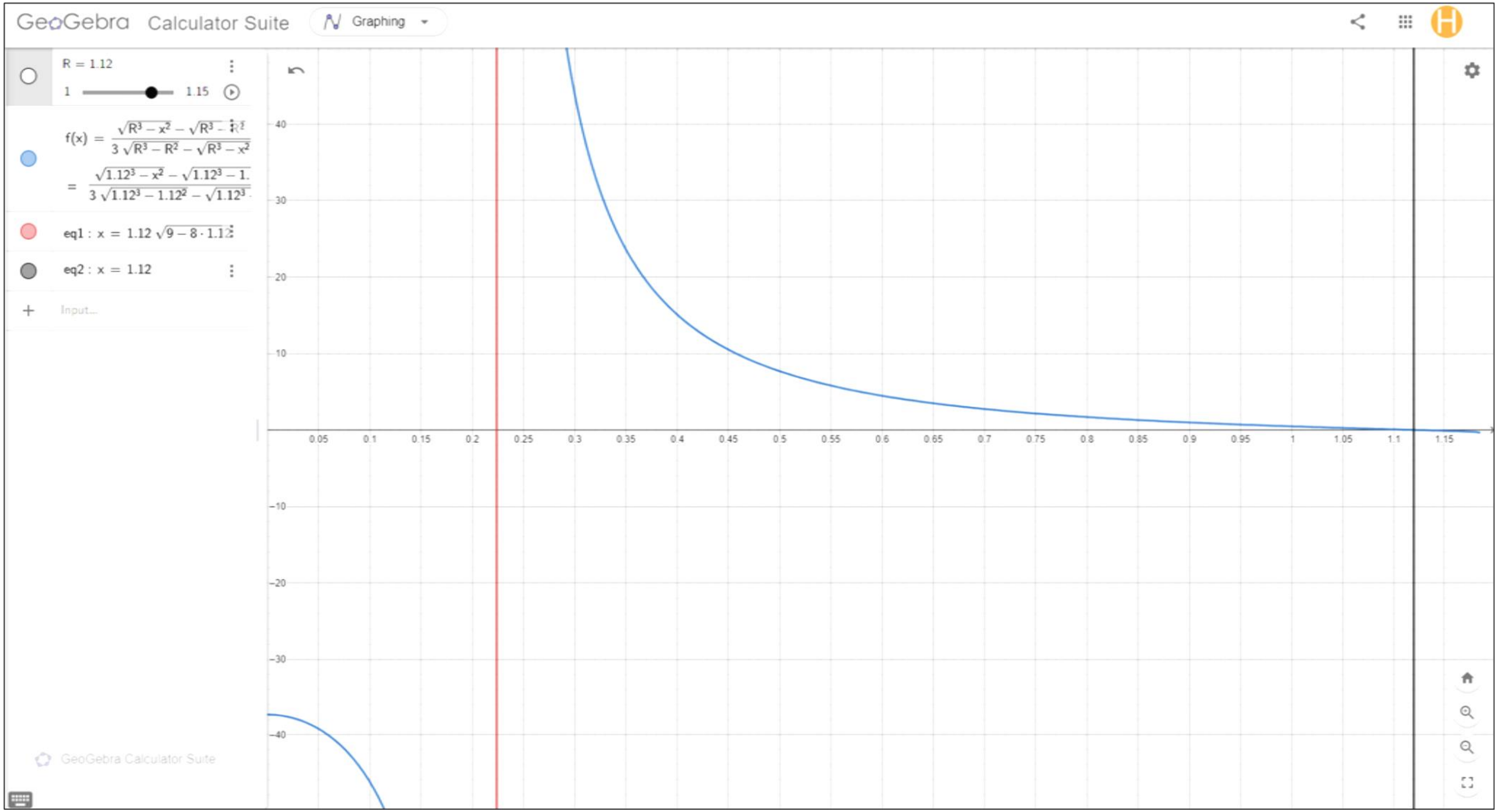
$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\ \ 0\le x=\rho\le 1.15\ ,\ \ \mathrm{R}=\boldsymbol{\rho_m=1.14>\frac{9}{8}}:$$



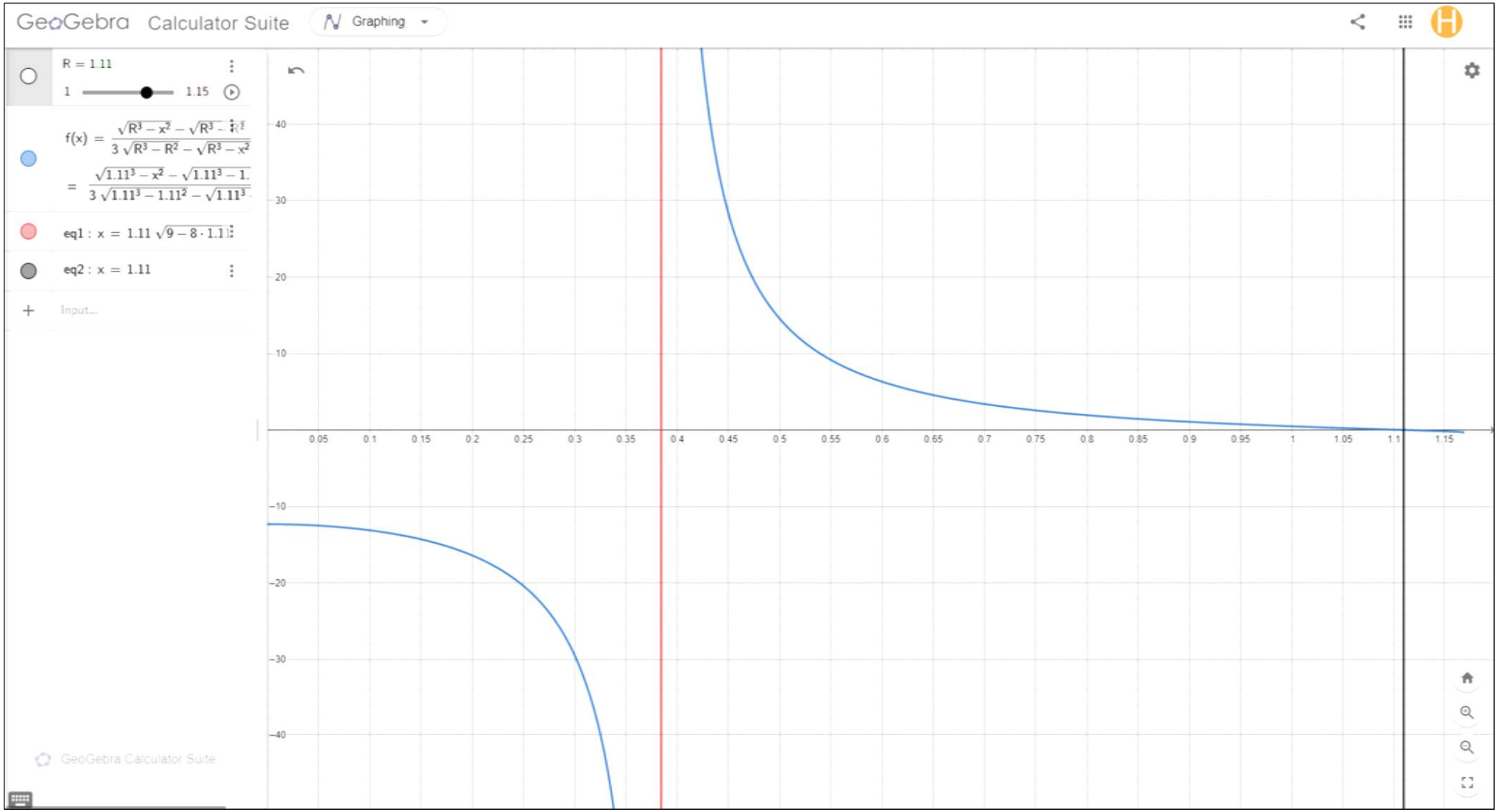
$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\;\; 0\le x=\rho\le 1.15\,,\;\; \mathrm{R}=\boldsymbol{\rho_m=1.13>\frac{9}{8}}:$$



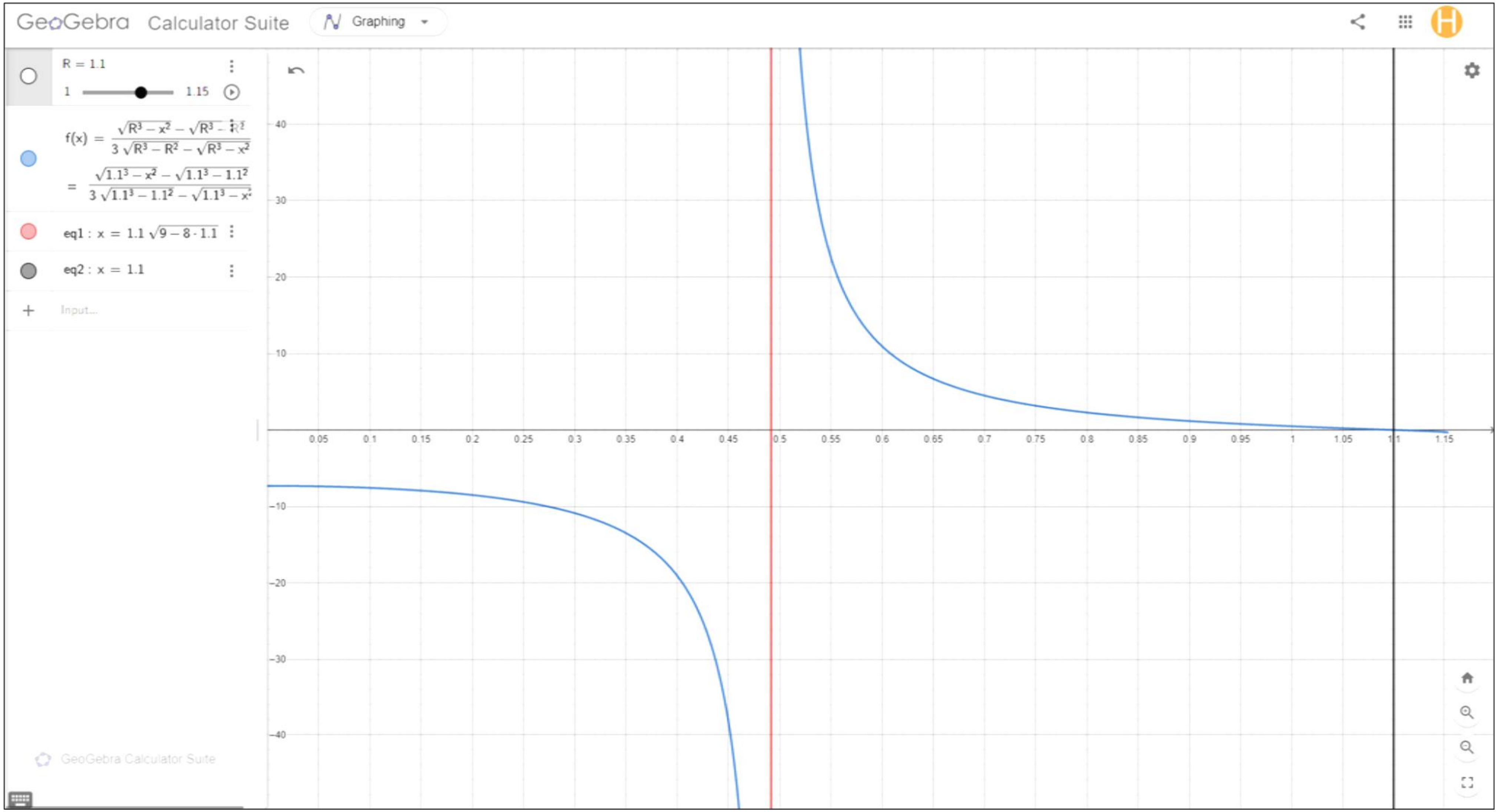
$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\quad 0\le x=\rho\le 1.15\,,\quad \mathrm{R}=\boldsymbol{\rho_m=1.12<\frac{9}{8}}:$$



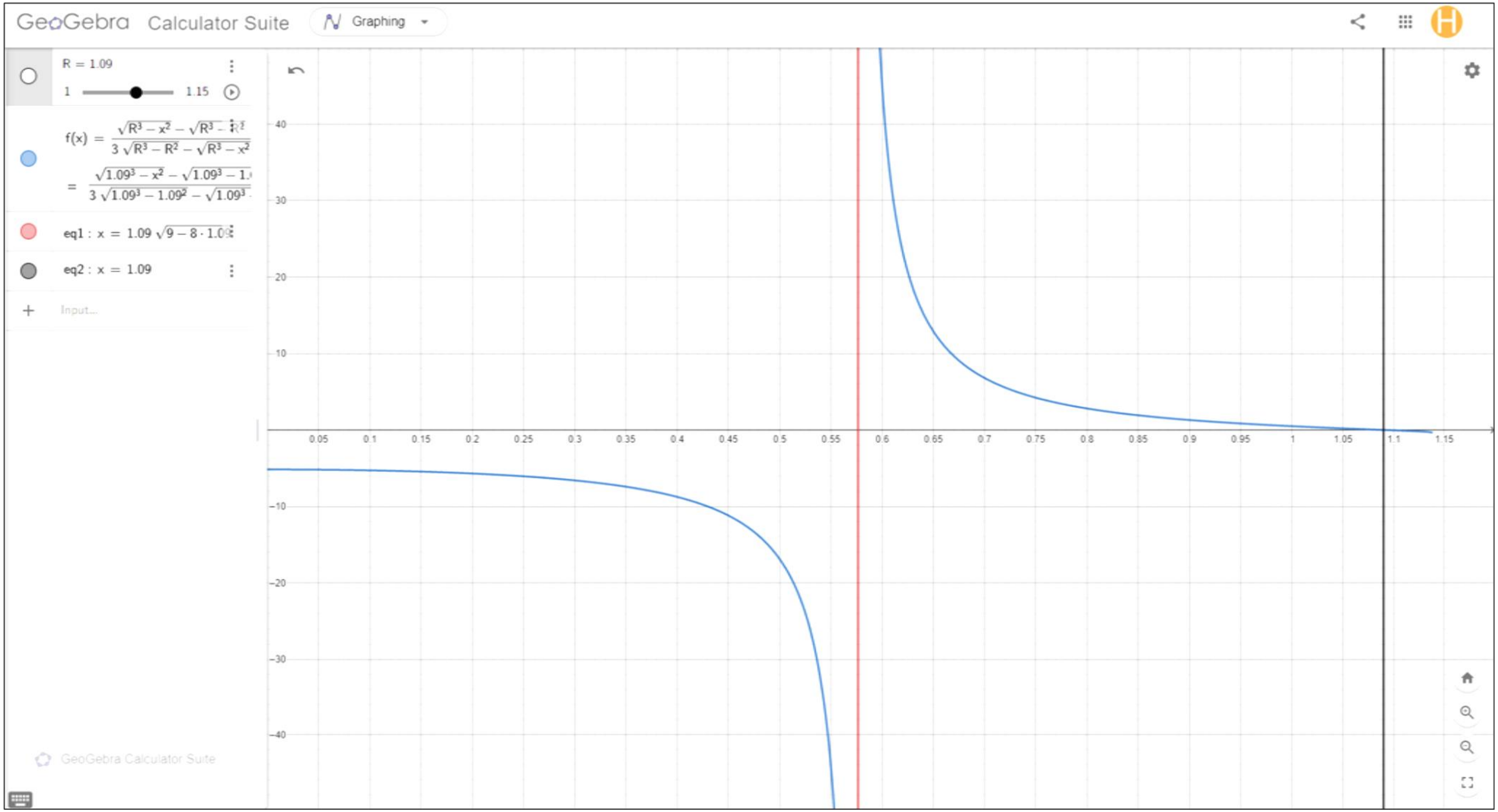
$$f(x=\rho; R=\rho_m) = \frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2}, \quad 0 \le x = \rho \le 1.15\,, \quad \mathrm{R} = \boldsymbol{\rho_m = 1.11 < \frac{9}{8}}:$$



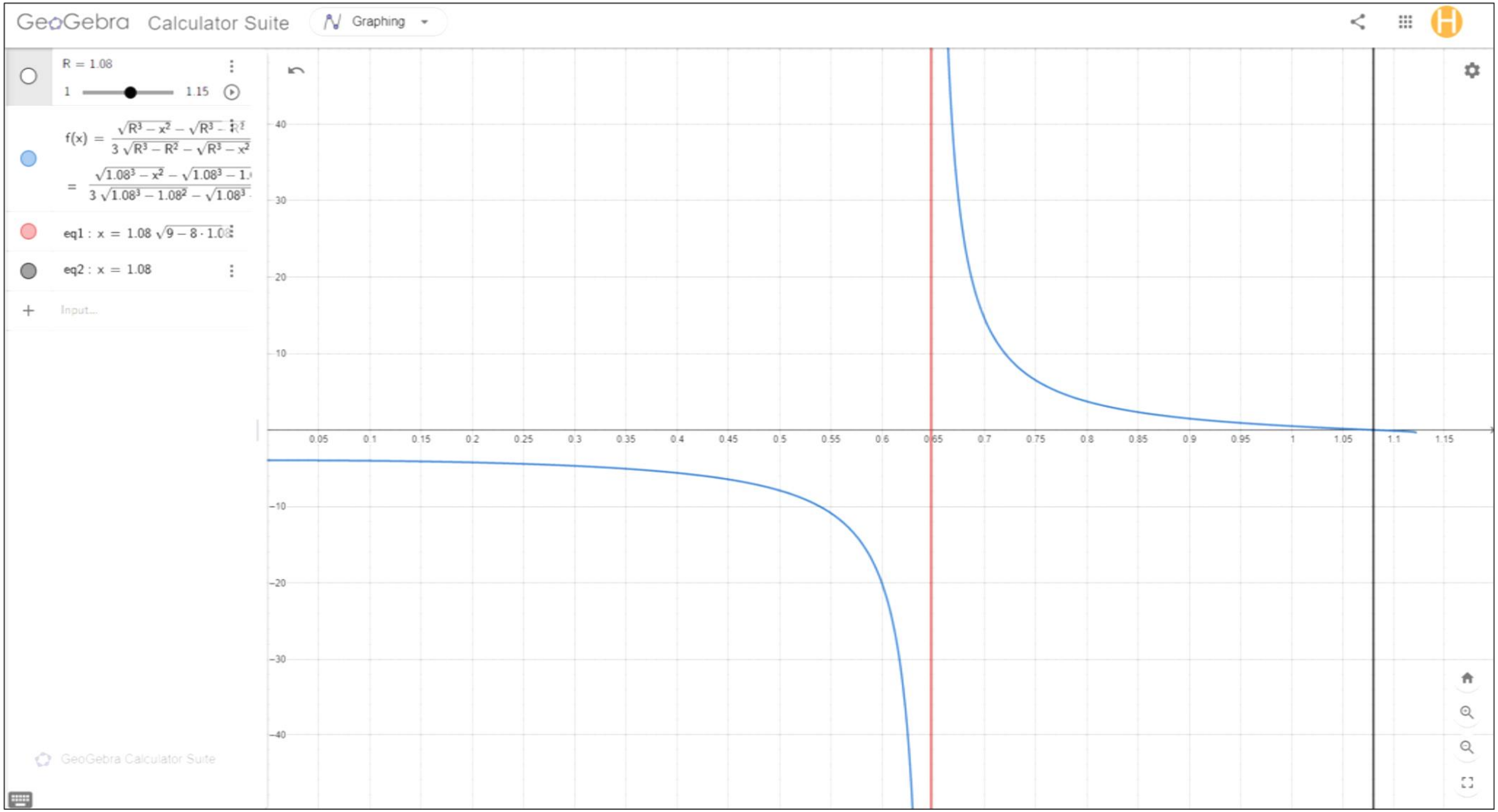
$$f(x=\rho; R=\rho_m) = \frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2}, \quad 0 \le x = \rho \le 1.15\,, \quad \mathrm{R} = \boldsymbol{\rho_m = 1.10 < \frac{9}{8}}:$$



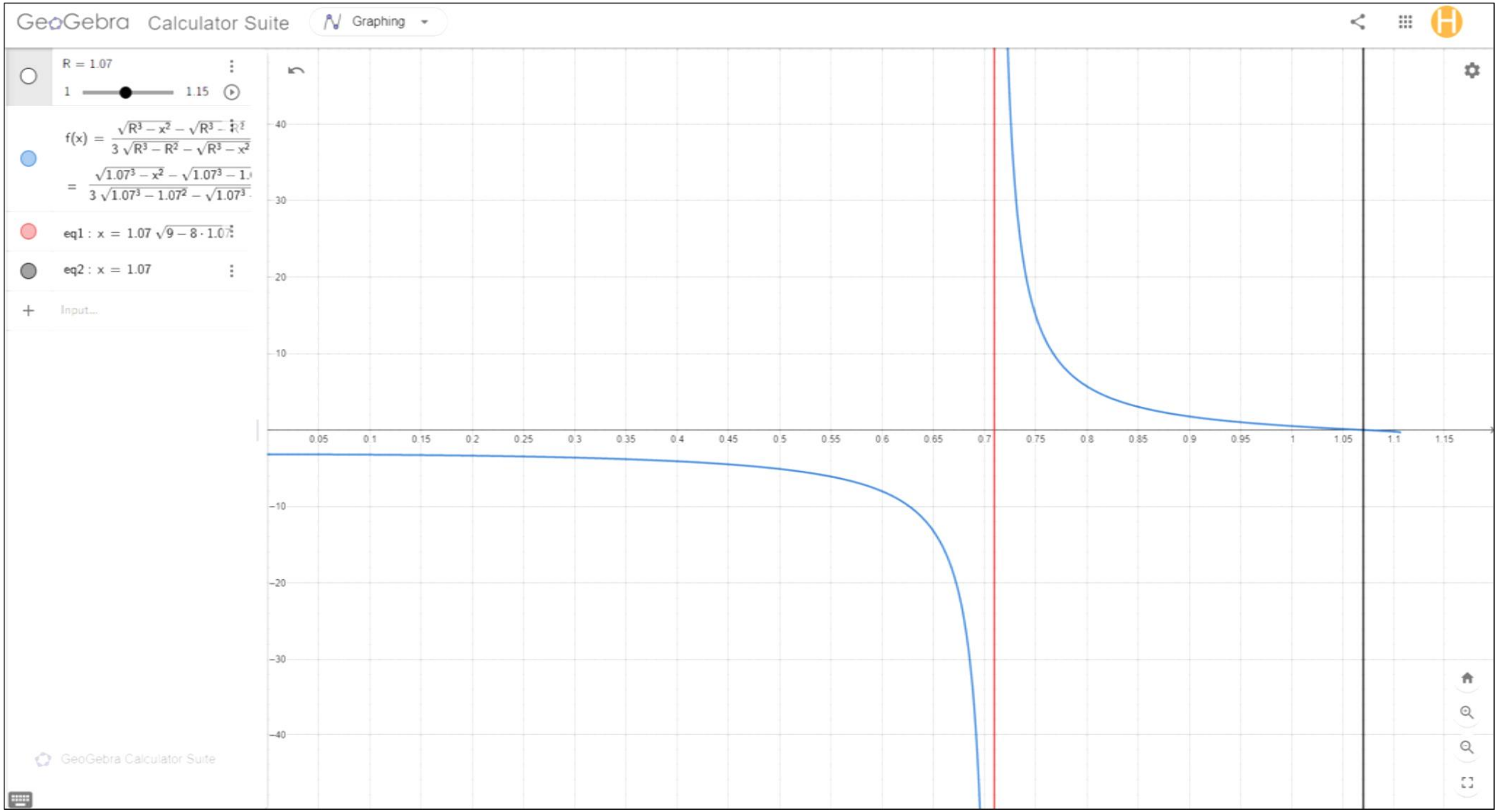
$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\ \ 0\le x=\rho\le 1.15\ ,\ \ \mathrm{R}=\boldsymbol{\rho_m=1.09<\frac{9}{8}}:$$



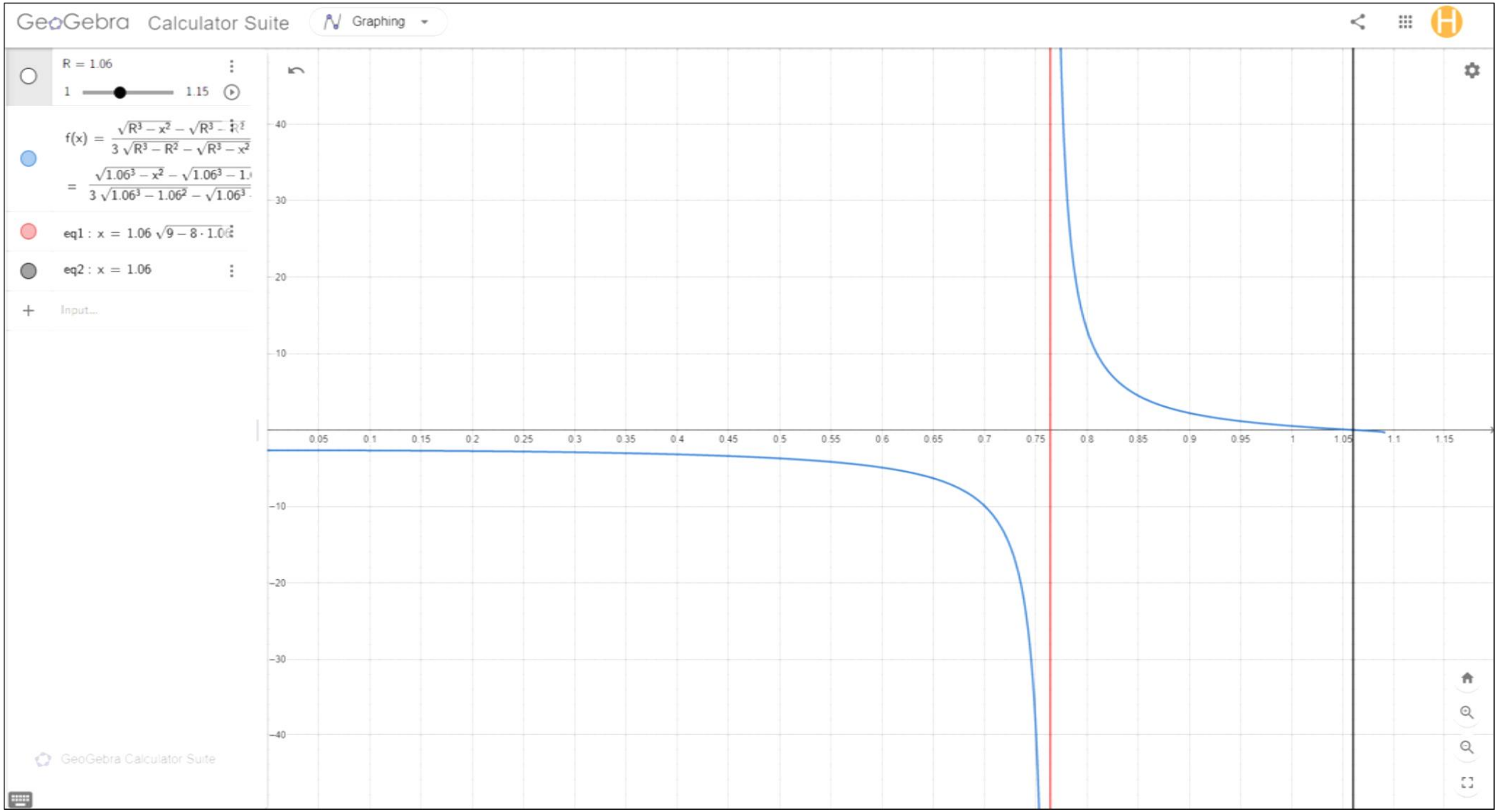
$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\quad 0\le x=\rho\le 1.15\,,\quad \mathrm{R}=\boldsymbol{\rho_m=1.08<\frac{9}{8}}:$$



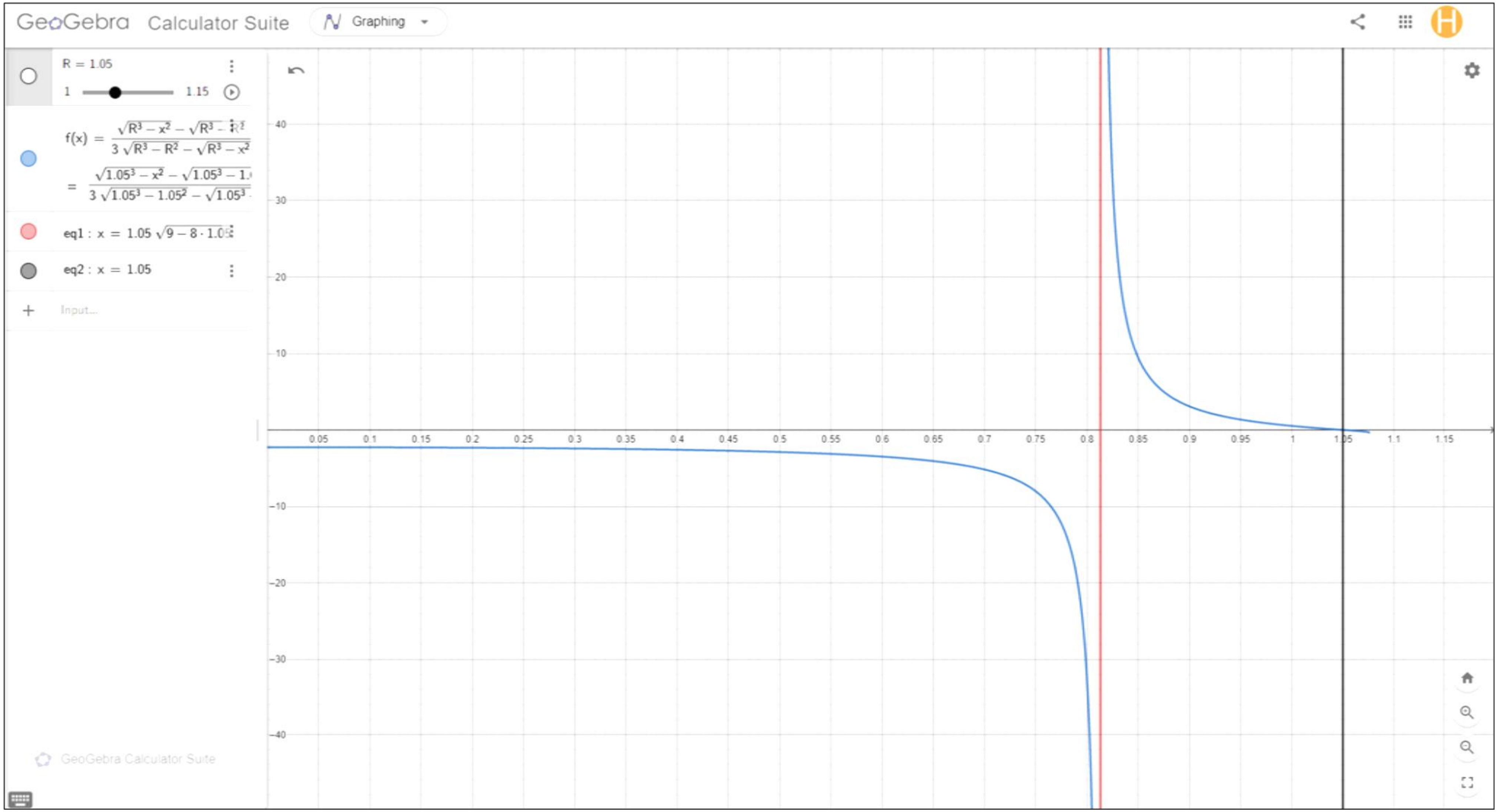
$$f(x=\rho; R=\rho_m) = \frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2}, \quad 0 \le x = \rho \le 1.15\,, \quad \mathrm{R} = \boldsymbol{\rho_m = 1.07 < \frac{9}{8}}:$$



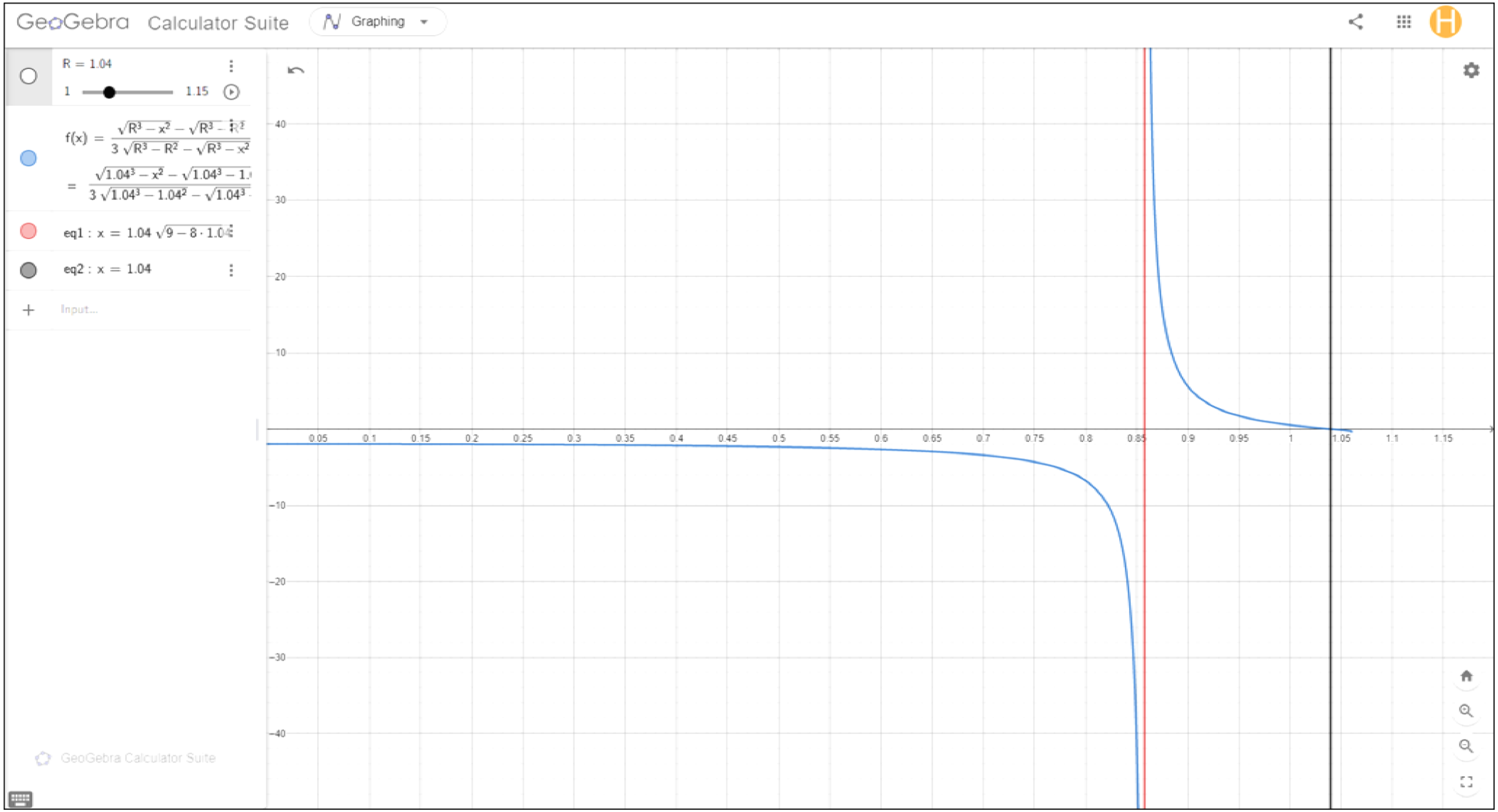
$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\ \ 0\leq x=\rho\leq 1.15\ ,\ \ \mathrm{R}=\boldsymbol{\rho_m=1.06<\frac{9}{8}}:$$



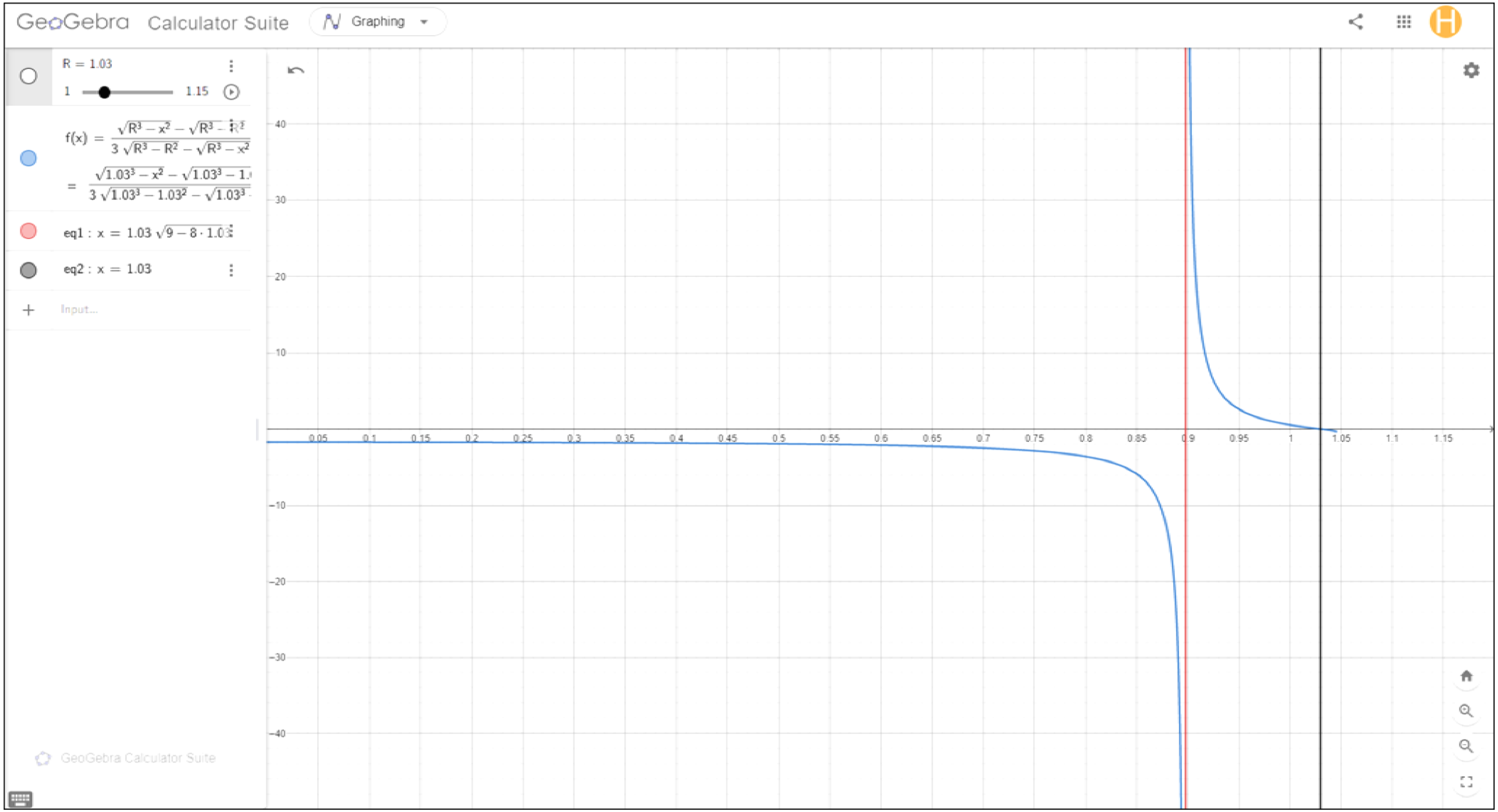
$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\ \ 0\le x=\rho\le 1.15\ ,\ \ \mathrm{R}={\color{red}\boldsymbol{\rho_m=1.05<\frac{9}{8}}}:$$



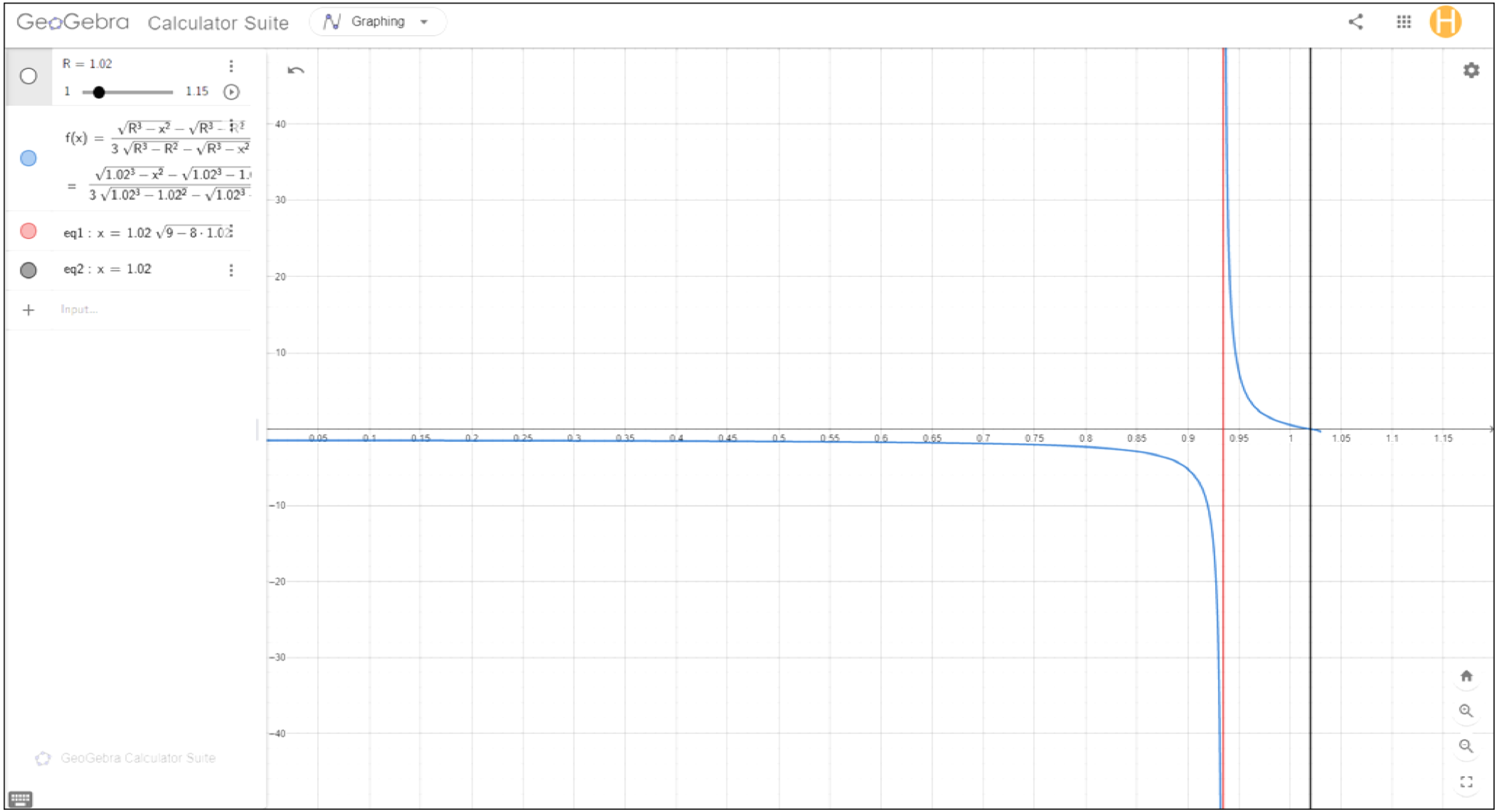
$$f(x=\rho; R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\quad 0\le x=\rho\le 1.15\,,\quad \mathrm{R}=\boldsymbol{\rho_m=1.04<\frac{9}{8}}:$$



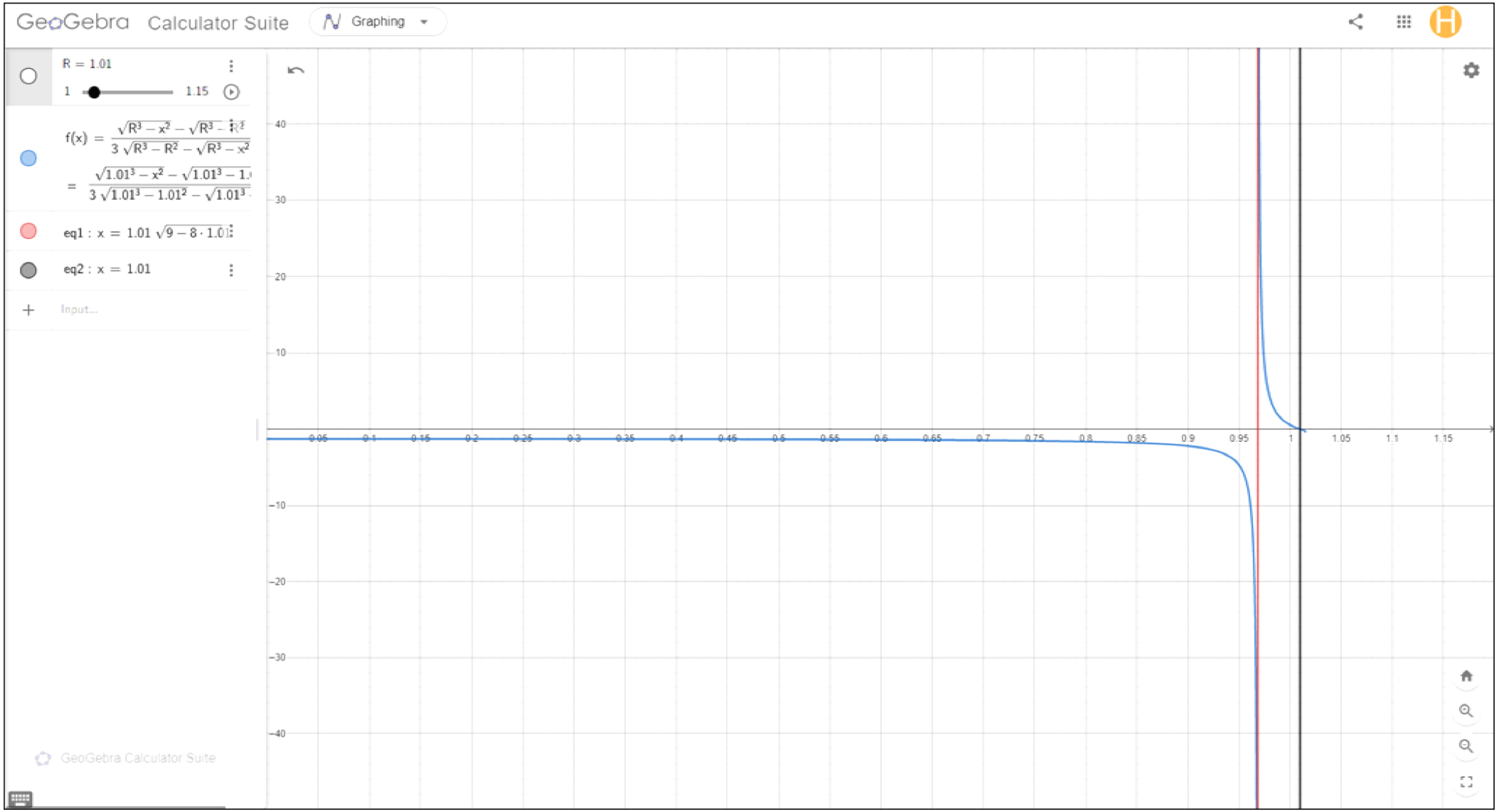
$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\quad 0\le x=\rho\le 1.15\,,\quad \mathrm{R}=\boldsymbol{\rho_m=1.03<\frac{9}{8}}:$$



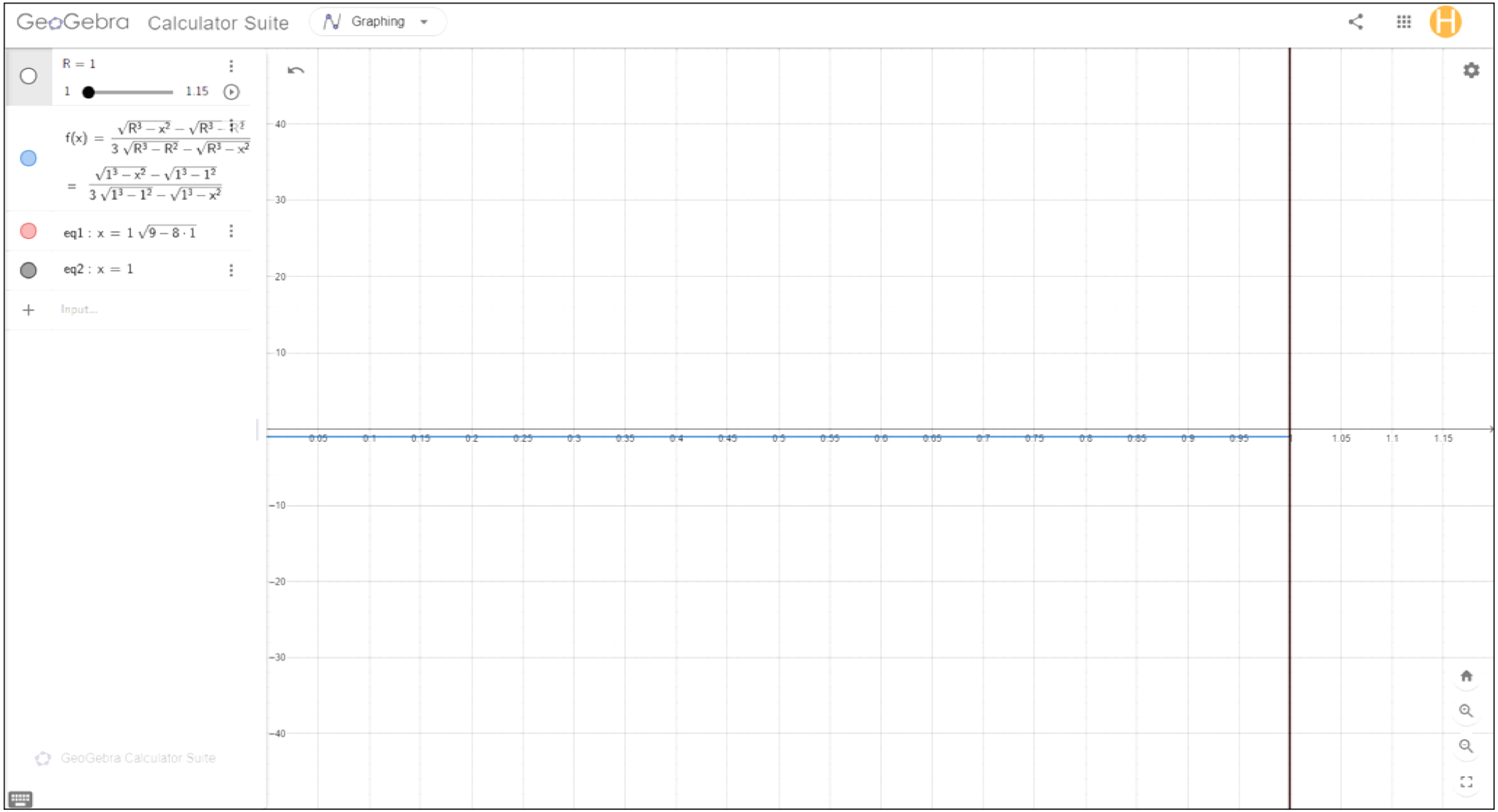
$$f(x=\rho; R=\rho_m) = \frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2}, \quad 0 \le x = \rho \le 1.15\,, \quad \mathrm{R} = \boldsymbol{\rho_m = 1.02 < \frac{9}{8}}:$$



$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\quad 0\le x=\rho\le 1.15\,,\quad \mathrm{R}=\boldsymbol{\rho_m=1.01<\frac{9}{8}}:$$



$$f(x=\rho;R=\rho_m)=\frac{p_{g,S}(\rho;\rho_m)}{\Omega c^2},\quad 0\le x=\rho\le 1.15\,,\quad \mathrm{R}=\boldsymbol{\rho_m}=\mathbf{1.00}<\frac{\mathbf{9}}{\mathbf{8}}:$$



You have just witnessed the
coming into being of a black hole!

According to the interior Schwarzschild solution,
a critical black hole has a homogeneous
& *expansive* internal gravitational pressure
equal to its mass-energy density.

Plausibly, the mass itself is homogeneous as well,
leaving NO singularity and NO trapped region
(at least not as empty space).

Incoming objects simply hit the thing, go to
smithereeens and become an integral part of it.

I am willing to ***presume***
this expansive & homogeneous pressure
inside the Schwarzschild sphere
is closely approximated by
compressible and inhomogeneous fluids,
i.e. it would apply to ***ALL*** black holes.

NO singularity!

As found in http://henk-reints.nl/astro/HR-fall-into-black-hole-slides.pdf, grav. time dil. & length contr. are by $\gamma_{\mathrm{ff}} = \frac{1+2\rho}{2\rho} \leq \frac{3}{2}$, which cannot make the thing black.

Might a BH be black due to the (unsurpassable) pressure asymptote?

Radiation pressure: $P_{\mathrm{inc}} = P_{\mathrm{refl}} = \frac{j}{c} \therefore P = P_{\mathrm{inc}} + P_{\mathrm{refl}} = \frac{2j}{c}$

PRESUMING: $T = T_{\mathrm{Hag}} \approx 1.22 \times 10^{12}\ \mathrm{K}$

SB yields: $j = \sigma_{\mathrm{SB}} T_{\mathrm{Hag}}^4 \approx 1.256 \times 10^{41}\ \mathrm{W/m^2}$

hence: $P \approx 8.38 \times 10^{32}\ \mathrm{Pa} \approx \frac{p_{\mathrm{C},n}}{100}$

NOTE: a factor applied to T must be raised to the 4th!

Radiation pressure (with reflection) equal to neutron Compton pressure if:

$$P_{\mathrm{inc}} = \frac{2\sigma_{\mathrm{SB}} T^4}{c} = \frac{4c^5 m_n^4}{\pi h^3} \therefore T = \sqrt[4]{\frac{2c^6 m_n^4}{\pi h^3 \sigma_{\mathrm{SB}}}}$$

$$\sigma_{\mathrm{SB}} = \frac{2\pi^5 k_{\mathrm{B}}^4}{15 c^2 h^3}$$

(https://en.wikipedia.org/wiki/Stefan%E2%80%93Boltzmann_law)

$$\boldsymbol{T} = \sqrt[4]{\frac{2c^6 m_n^4}{\pi h^3} \cdot \frac{15 c^2 h^3}{2\pi^5 k_{\mathrm{B}}^4}} = \sqrt[4]{\frac{15 c^8 m_n^4}{\pi^6 k_{\mathrm{B}}^4}} = \sqrt[4]{\frac{15}{\pi^6}} \cdot \frac{m_n c^2}{k_{\mathrm{B}}} \approx \mathbf{3.85 \times 10^{12}\ K} \approx \mathbf{3.16} \cdot \boldsymbol{T}_{\mathbf{Hag}}$$

Compton volume $:=$ sphere with $r = \lambda_\mathrm{C}/2$

see: http://henk-reints.nl/astro/HR-fall-into-black-hole-slides.pdf

for a further explanation of Compton volume, density & pressure.

Plausible incompressible fluids:	Density	Minimal BH mass $\sqrt{\frac{3c^6}{32\pi G^3\Omega}}$	Schw. radius $\sqrt{\frac{3c^2}{8\pi G\Omega}}$
neutronium at Compton density:	$\Omega_{\mathrm{C},n} = \frac{6c^3 m_n^4}{\pi h^3}$ $\approx 1.392 \times 10^{18}$ kg/m^3	$3.638\ M_\odot$	10.75 km
close-packed neutronium:	$\Omega_{\mathrm{cp},n} = \frac{\pi}{3\sqrt{2}} \cdot \frac{3m_n}{4\pi r_n^3}$ $\approx 5.8 \times 10^{17}$ kg/m^3	$5.637\ M_\odot$	16.65 km
proton+electron plasma at Compton density:	$\Omega_{\mathrm{C},pe} = \frac{m_p + m_e}{V_{\mathrm{C},p} + V_{\mathrm{C},e}}$ $\approx 2.238 \times 10^{8}$ kg/m^3	$2.870 \times 10^5 M_\odot$	847 500 km $\approx$ 2.205 lun
IMPLAUSIBLE: electron Compton density:	$\Omega_{\mathrm{C},e} = \frac{6c^3 m_e^4}{\pi h^3}$ $\approx 1.218 \times 10^{5}$ kg/m^3	$1.230 \times 10^7 M_\odot$	36.33×10^6 km 0.2428 au

BH mass where (expansive) Schw. pressure ($p_{g,S}$) equals particle's resistive pressure:

$$\Omega_S = \frac{3M}{4\pi r_S^3} = \frac{3M}{4\pi\left(\frac{2GM}{c^2}\right)^3} = \frac{3c^6}{32\pi G^3 M^2}, \qquad p_{g,S} = \Omega_S c^2 = \frac{3c^8}{32\pi G^3 M^2}$$

Compton neutronium: $p_{g,S} = p_{C,n} = \frac{4c^5 m_n^4}{\pi h^3} \approx 8.34 \times 10^{34}$ **Pa** $\quad \therefore \frac{3c^8 \cdot \pi h^3}{32\pi G^3 \cdot 4c^5 m_n^4} = M^2$

$\therefore M = \sqrt{\frac{3c^3 h^3}{128 G^3 m_n^4}} \approx 8.86 \times 10^{30}$ **kg** $\approx 4.46\, M_\odot \quad r_S \approx 13$ **km**

Close-packed neutronium: $p_{g,S} = p_{cp,n} = \frac{2}{3}\Omega_{cp,n} c^2 \approx 3.48 \times 10^{34}$ **Pa** $\quad \therefore \frac{9c^6}{64\pi G^3 M^2} = \Omega_{cp,n}$

$\therefore M = \sqrt{\frac{9c^6}{64\pi G^3 \Omega_{cp,n}}} \approx 1.37 \times 10^{31}$ **kg** $\approx 6.9\, M_\odot \quad r_S \approx 20$ **km**

***pe*-plasma Compton press.:** $p_{g,S} = p_{C,pe} = \frac{2}{3}\Omega_{C,pe} c^2 \approx 1.34 \times 10^{25}$ **Pa** $\quad \therefore \frac{9c^6}{64\pi G^3 M^2} = \Omega_{C,pe}$

$\therefore M = \sqrt{\frac{9c^6}{64\pi G^3 \Omega_{C,pe}}} \approx 6.99 \times 10^{35}$ **kg** $\approx 351\,000\, M_\odot \quad r_S \approx 2.7$ **lun**

electron Compton pressure: $p_{g,S} = p_{C,e} = \frac{4c^5 m_e^4}{\pi h^3} \approx 7.30 \times 10^{21}$ **Pa** $\quad \therefore \frac{3c^8 \cdot \pi h^3}{32\pi G^3 \cdot 4c^5 m_e^4} = M^2$

$\therefore M = \sqrt{\frac{3c^3 h^3}{128 G^3 m_e^4}} \approx 2.996 \times 10^{37}$ **kg** $\approx 1\,500\,000\, M_\odot \quad r_S \approx 116$ **lun** ≈ 0.3 **au**

WOULD the thing consist of "diluted" neutronium which is out of reach of the strong nuclear force (but gravitationally bound & ignoring TOV), its density would be about $\Omega_{\mathrm{cp},n}/3^3 = \Omega_{\mathrm{cp},n}/27$ $\approx \mathbf{2.14 \times 10^{16}\ kg/m^3}$ and its mass would approximate $\sqrt{27}\, M_{\mathrm{cp},n}$:

$$\therefore \boldsymbol{M} = \sqrt{\frac{27 \cdot 9c^6}{64\pi G^3 \Omega_{\mathrm{cp},n}}} \approx \mathbf{7.13 \times 10^{31}\ kg} \approx \mathbf{36}\ \boldsymbol{M_\odot} \qquad \boldsymbol{r_\mathrm{S}} \approx \mathbf{106\ km}$$

But wouldn't such diluted neutronium be prone to β-decay?

However, it is inside a BH, so no β particles can exit the thing.

An equilibrium would arise with electron capture at same rate as this decay.

Moreover: $\boldsymbol{p_{g,\mathrm{S}}} \approx \mathbf{1.3 \times 10^{33}\ Pa} \gg \boldsymbol{p_{\mathrm{C},e}} \approx \mathbf{7.3 \times 10^{21}\ Pa}$**,**

so electrons would be crushed and not be able to exist[6] at all.

$\therefore \mathbf{36}\ \boldsymbol{M_\odot}$ would be a reasonable upper boundary to $M_{\mathrm{BH},n}$;

heaviest known stellar BH: Cygnus X-1 has $\mathbf{19.0} \lesssim M/M_\odot \lesssim \mathbf{23.4}$

lightest known SMBH: NGC 7314 has $\mathbf{420\,000} \lesssim M/M_\odot \lesssim \mathbf{1\,320\,000}$

(only BHs of which I could find the mass; search date: 2023-04-23)

[6] see: http://henk-reints.nl/astro/HR-fall-into-black-hole-slides.pdf

The greater the BH's mass,
the less its (expansive) Schwarzschild pressure.

IF this pressure would be *compress*ive,
the substance would be crushed if it where
a BH *below* any of the above (critical) masses.

Instead, the thing ***PRESUMABLY*** expands to $r > r_S$.
This *would/could* mean a black hole must have:

$4.46 \lesssim M_{BH}/M_\odot \lesssim 36$ or $351\,000 \lesssim M_{BH}/M_\odot$

i.e. *intermediate*, *mini*, let alone *micro* BHs *cannot* exist.
They are merely a *fiction*. There exist *only* stellar BHs & SMBHs.

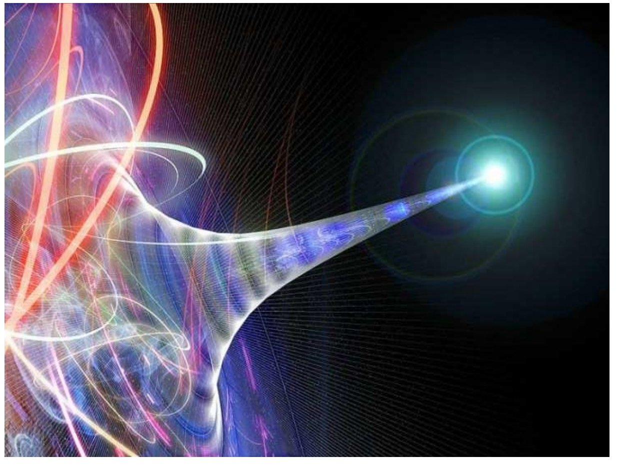
To my knowledge, no law of nature disallows a body
of such an intermediate mass, but it cannot be a BH.
More likely: neutronium core with (cold = dark) plasma shell.

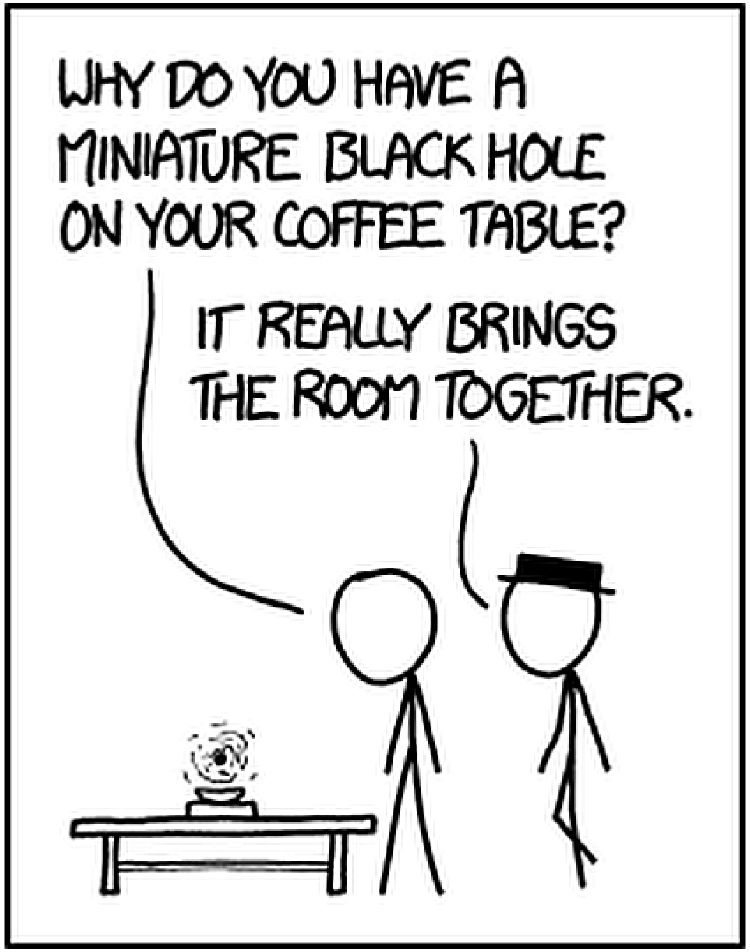
Scientia = ***know**ledge*.

In physics (or science in general),

there is ***NO PLACE*** for *fictions* like

singularities & artist's impressions.

BUNK  UM!



https://www.explainxkcd.com/wiki/index.php/1680:_Black_Hole

