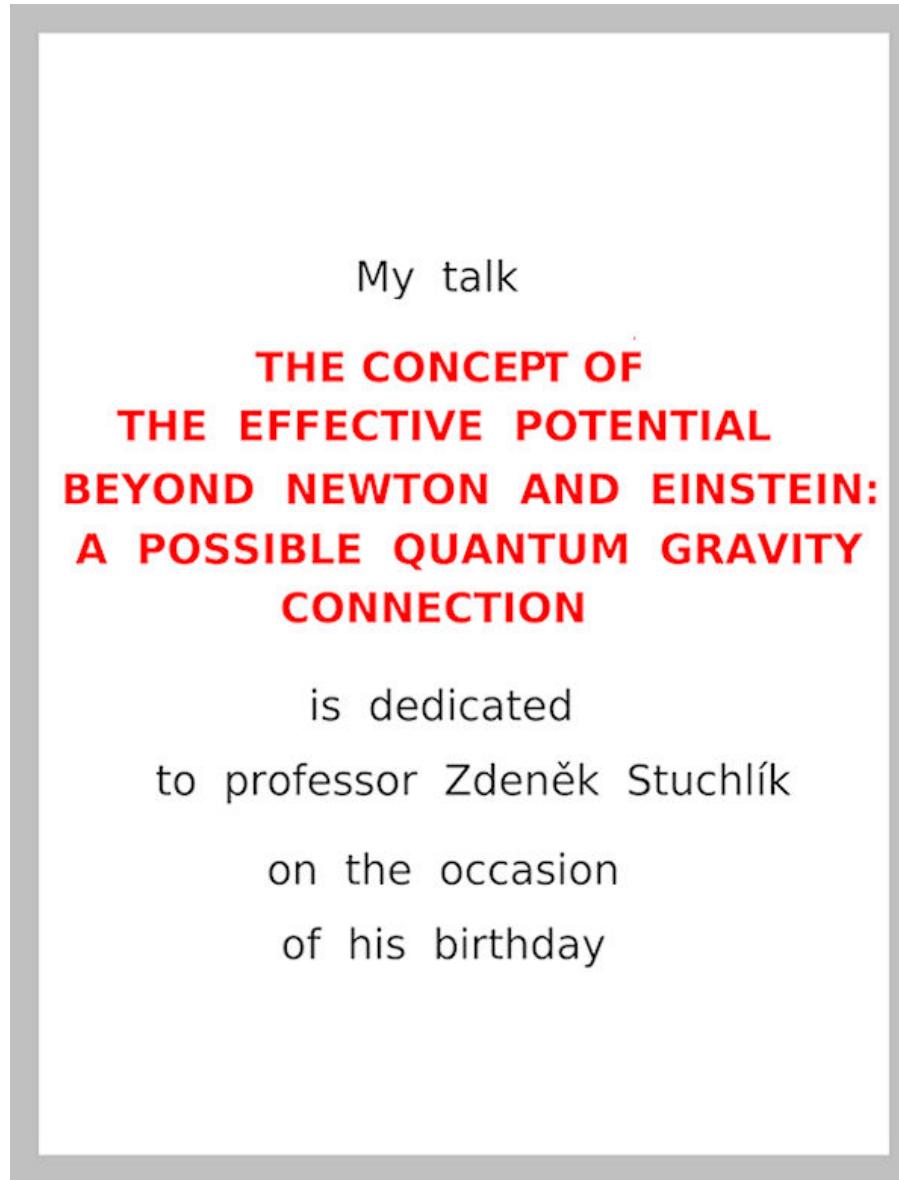


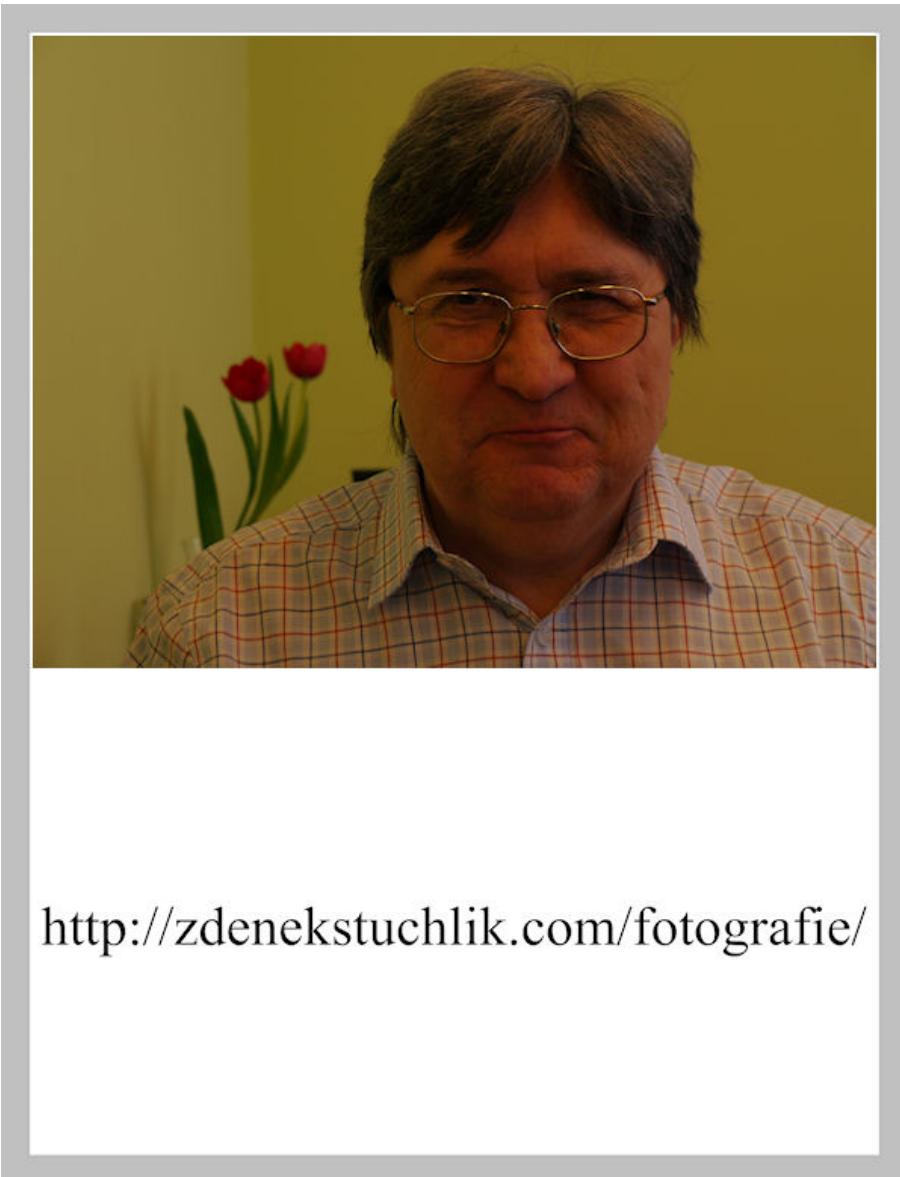
# Happy birthday Zdeněk !!!

(1)



# Happy birthday Zdeněk !!!

(2)



<http://zdenekstuchlik.com/fotografie/>

A screenshot of a website for Zdeněk Stuchlík. The top navigation bar includes links for BIO, FYZIKA, V MÉDIÍCH, and FOTOGRAFIE. Below the navigation, there are four photo albums: BERLÍN (November 27, 2016, 1 picture), KARVINA (November 27, 2016, 9 pictures), OPAVA (November 27, 2016, 12 pictures), and OXFORD (November 27, 2016, 18 pictures). Each album thumbnail shows a representative image from the collection.

# Silhouettes

(3)



# My Opava connection 15 yrs ago and a past birthday

(4)



Birthday on **red**. Picasso on **green**.

## A Characterization of the COVID-19 Pandemic Impact on a Mobile Network Operator Traffic

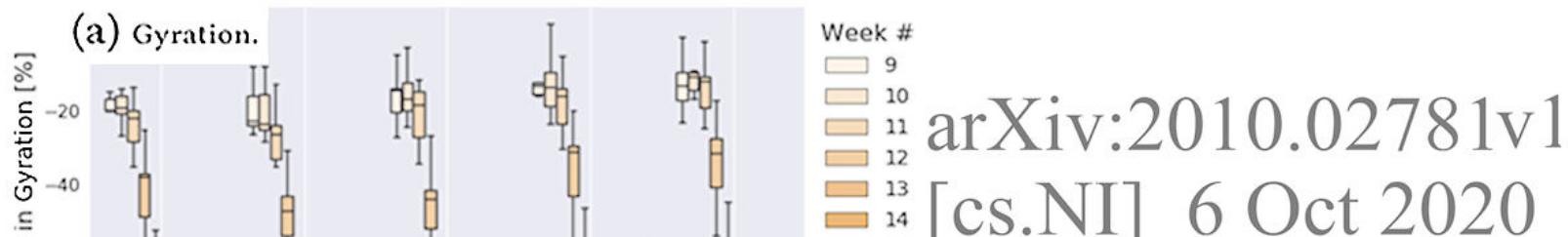
Andra Lutu  
Telefonica Research

Diego Perino  
Telefonica Research

Marcelo Bagnulo  
Universidad Carlos III de Madrid

Enrique Frias-Martinez  
Telefonica Research

Javad Khangosstar  
Telefonica UK



arXiv:2010.02781v1  
[cs.NI] 6 Oct 2020

## REFERENCES

- [1] 3GPP. [n. d.]. 3rd Generation Partnership Project (3GPP). ([n. d.]). Retrieved May 14, 2020 from <https://www.3gpp.org>
- [2] MA Abramowicz, JC Miller, and Z Stuchlík. 1993. Concept of radius of gyration in general relativity. *Physical Review D* 47, 4 (1993), 1440.

## Summary & Conclusions

(6)

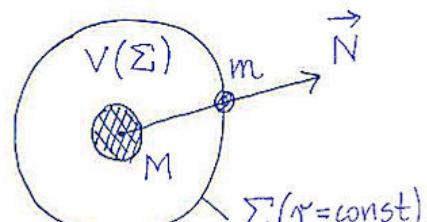
I shortly describe the concept of the effective potential in Newton's theory and show that even if one does not know Einstein's general relativity, one may correctly guess the topology of the potential in Einstein's theory from Newton's theory.

This allows one to discover, without solving any of Einstein's equations, all "relativistic effects" in particles' and photons' motion around compact objects in the strong field limit.

Here I speculate that the same is true for quantum effects in strong gravity: even without knowing Quantum Gravity (QG) theory, one may guess all classes of all the QG effects, in principle observable in particles' and photons' motion around compact Quantum Gravity objects. This may be relevant for interpreting the EHT images (in particular secondary rings) and the LIGO-Virgo results (in particular ringdowns and echoes).

# Newton & Einstein: a short reminder

(7)

	NEWTON	EINSTEIN
FIELD EQUATIONS	$\nabla^2 \Phi = 4\pi G g$ $\frac{\partial^2 (\text{FIELD})}{\partial (\text{SPACE})^2} = (\text{MATTER})$	$G_{ik}^{ij} = \chi T_{ik}^{ij}$ $\frac{\partial^2 (\text{FIELD})}{\partial (\text{SPACE})^2} - \frac{1}{c^2} \frac{\partial^2 (\text{FIELD})}{\partial (\text{TIME})^2} = (\text{MATTER})$ <u>GRAVITATIONAL WAVES</u>
MOTION	$\vec{F} = m \vec{a}$ $\vec{F} = (\vec{F}_R + \vec{F}_G); \vec{F}_G = -m \vec{\nabla} \Phi$ <u>REAL FORCE</u> <u>GRAVITY FORCE</u>	$\vec{F}_R = m \vec{a}$ "INCLUDES GRAVITY" EINSTEIN'S ELEVATOR: GRAVITY IS NOT A FORCE
	$4\pi G M = \iiint_{V(\Sigma)} \nabla^2 \Phi dV = \iint_{\Sigma(r')} (\vec{\nabla} \Phi) \vec{N} dS$ $F_G = -\frac{GM}{r^2}$	$\left\{ \begin{array}{l} \text{GAUSS} \\ \Sigma(r') \\ (\vec{F}_G \cdot \vec{N} = F_G) \\ \iint dS = 4\pi r'^2 \end{array} \right.$

# Our approach: exact topology, no approximations

(8)

Now, we will use only Newtonian arguments plus an extra one: that speed of light is an upper limit for physical velocities.

From this we will derive most important aspects of Einstein's celestial dynamics in the strong field.

This approach is different from all approximate approaches:  
it is topologically exact.

# Energy & momentum conservation

(9)

NEWTON: CONSERVATION OF ENERGY &  
AND ANGULAR MOMENTUM  $\ell$

$\frac{\partial(\text{field})}{\partial t} = 0 \Rightarrow \text{ENERGY CONSERVATION}$   $\frac{dE}{dt} = 0$

$\frac{\partial(\text{field})}{\partial \varphi} = 0 \Rightarrow \text{ANGULAR MOMENTUM CONSERVATION}$   $\frac{d\ell}{dt} = 0$

$$\frac{d\Phi}{dt} = \frac{\partial \Phi}{\partial t} + \frac{\partial \Phi}{\partial x} \frac{dx}{dt} = -v \frac{dv}{dt} = -\frac{d}{dt} \left( \frac{1}{2} v^2 \right) \Rightarrow \frac{d}{dt} \left( \Phi + \frac{1}{2} v^2 \right) = 0$$

$\uparrow = E$

$$\frac{d\ell}{dt} = \frac{d}{dt} (S r^2) = \frac{d}{dt} \left( \frac{d\varphi}{dt} r^2 \right) = \frac{d^2 \varphi}{dt^2} r^2 + 2 \frac{d\varphi}{dt} \frac{dr}{dt} r = \alpha_\varphi$$

$$\alpha_\varphi = -\frac{1}{r} \frac{\partial \Phi}{\partial \varphi} = 0 \Rightarrow \frac{d\ell}{dt} = 0$$

# Effective potential in Newton's theory (1)

(10)

THE EFFECTIVE POTENTIAL IN NEWTON'S THEORY

$$\xi = \frac{E}{m} = \Phi + \frac{1}{2}v^2 = \Phi + \frac{1}{2}v_r^2 + \frac{1}{2}v_\varphi^2; \quad v_\varphi^2 = \left(\frac{l}{r}\right)^2$$

$$\xi = \Phi + \frac{1}{2}v_r^2 + \frac{1}{2}\left(\frac{l^2}{r^2}\right)$$

$$0 \leq \frac{1}{2}v^2 = \xi - \left[\Phi + \frac{1}{2}\frac{l^2}{r^2}\right]$$

$\uparrow = U(r, l) = \text{effective}$

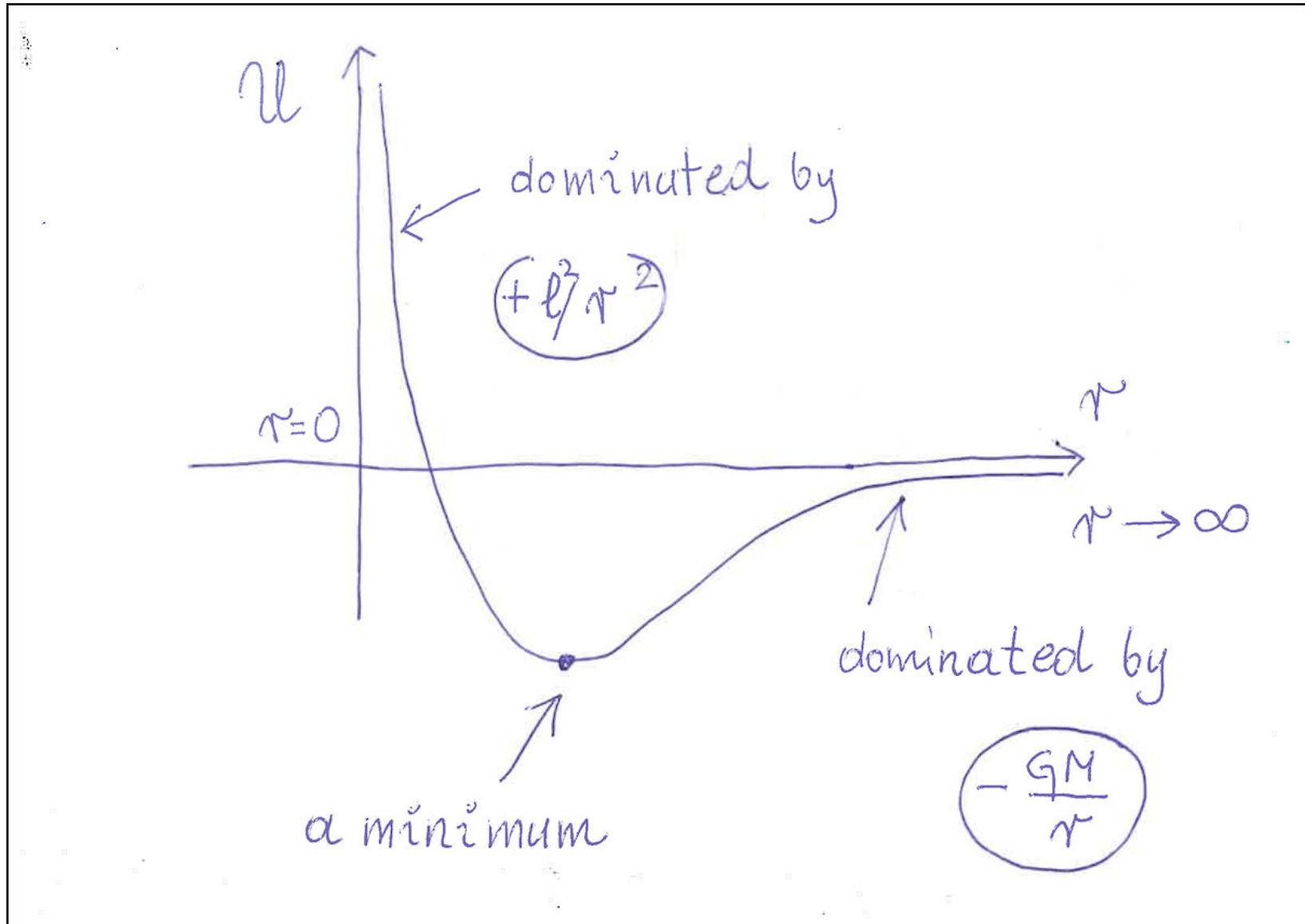
$$\xi \geq U(r, l) \leftarrow \boxed{\text{CONDITION FOR MOTION}}$$

For the potential  $-\frac{GM}{r}$

$$U = U(r, l) = -\frac{GM}{r} + \frac{1}{2}\left(\frac{l^2}{r^2}\right)$$

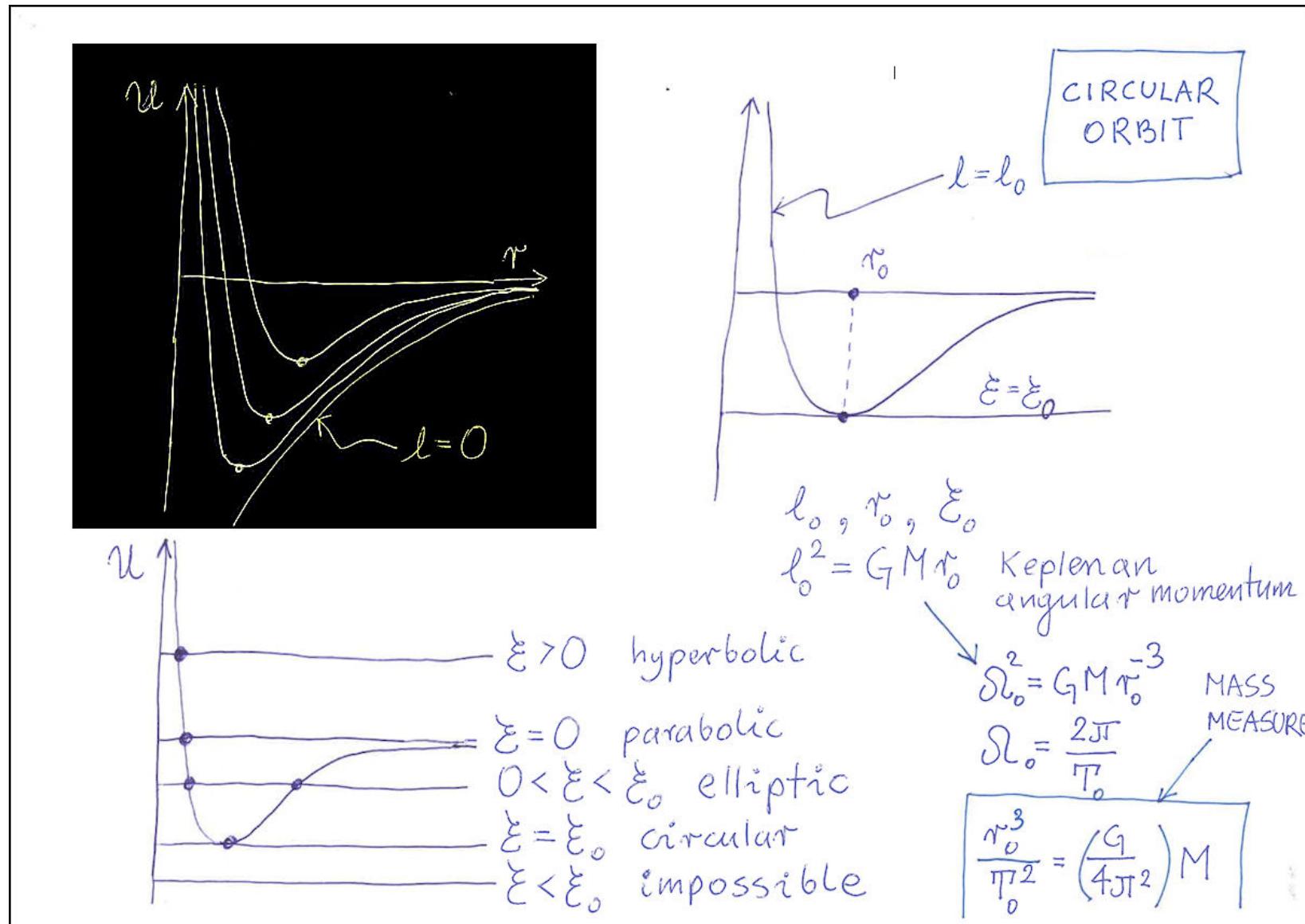
## Effective potential in Newton's theory (2)

(11)



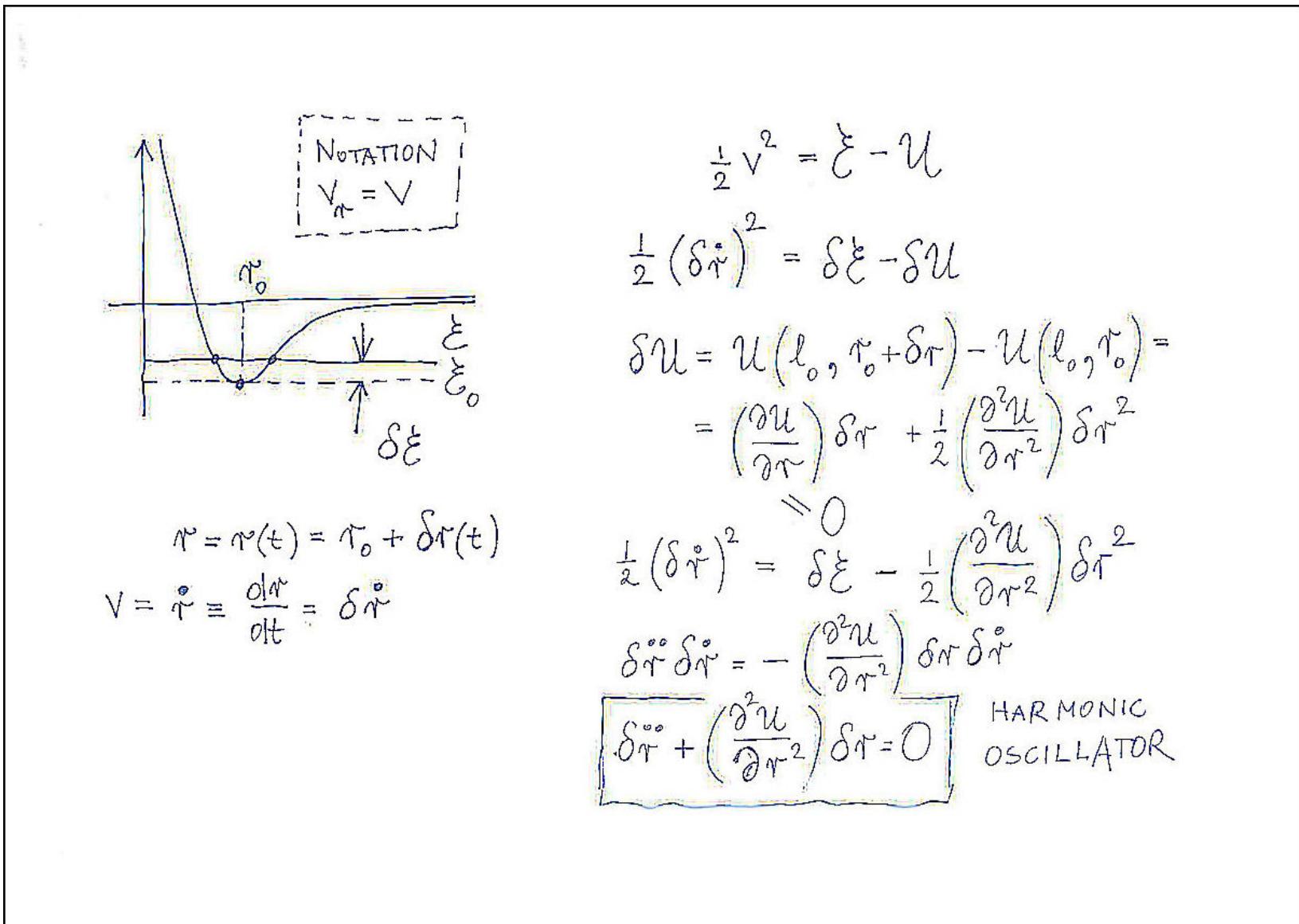
# Effective potential in Newton's theory (3)

(12)



# Almost circular orbits (1)

(13)



## Almost circular orbits (2)

(14)

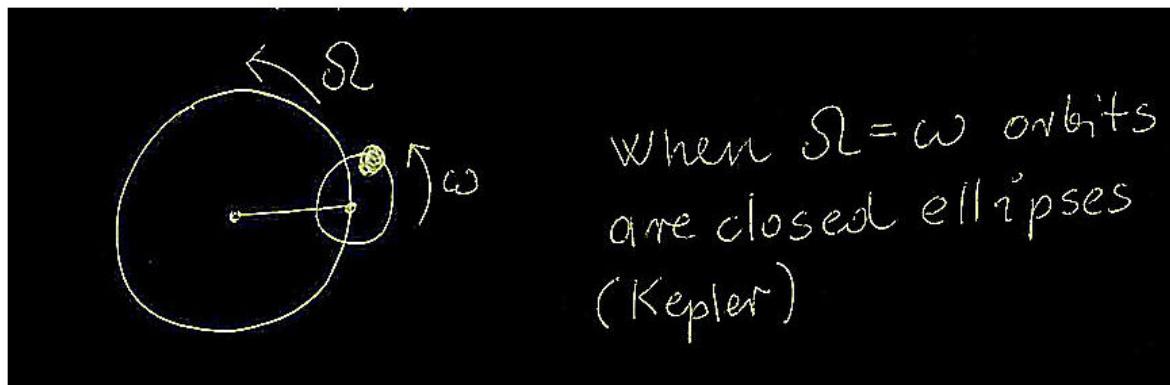
$$\ddot{\delta r} + \left( \frac{\partial^2 U}{\partial r^2} \right) \delta r = 0$$

$\uparrow = \omega^2 = \text{epicyclic frequency}$

$\omega^2 >$  for stability

In Newton's potential  $\Phi = -\frac{GM}{r}$

$$\Omega = \left( \frac{GM}{r^3} \right)^{\frac{1}{2}} \quad \omega = \left( \frac{GM}{r^3} \right)^{\frac{1}{2}} = \Omega$$



# Newton summary

(15)

$$\nabla^2 \Phi = 4\pi G S , \quad \vec{F} = m \vec{a} , \quad \vec{a} = \frac{d \vec{v}}{dt} , \quad \vec{v} = \frac{d \vec{x}}{dt}$$

$$\frac{\partial \Phi}{\partial t} = 0 \Rightarrow \frac{d \mathcal{E}}{dt} = 0 , \quad \frac{\partial \Phi}{\partial \varphi} = 0 \Rightarrow \frac{dl}{dt} = 0$$

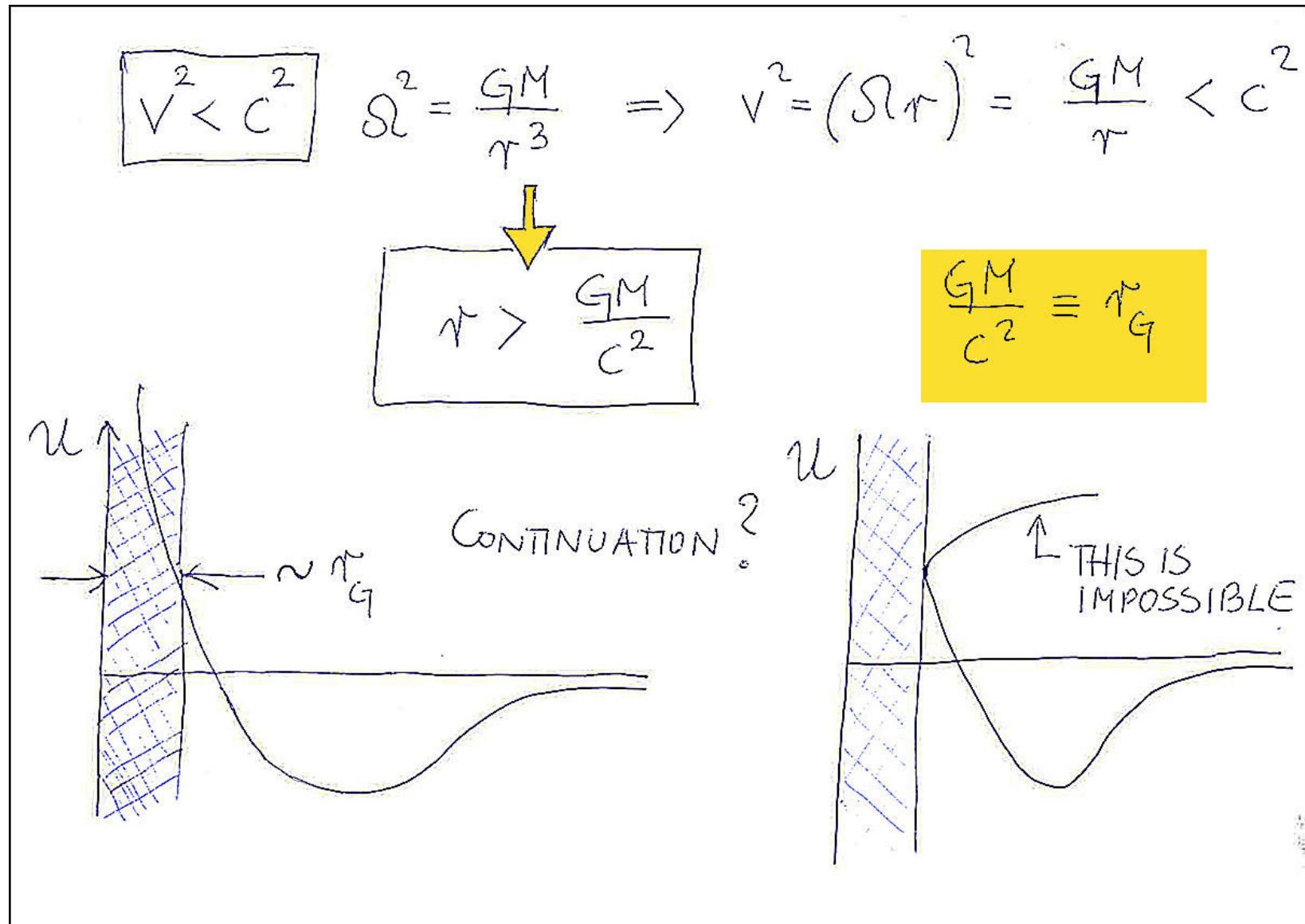
$$\mathcal{E} = \Phi + \frac{1}{2} V_r^2 + \frac{1}{2} \left( \frac{l}{r} \right)^2 \Rightarrow \frac{1}{2} V_r^2 = \mathcal{E} - \left[ \Phi + \frac{1}{2} \left( \frac{l}{r} \right)^2 \right]$$

$$\left( \frac{\partial U}{\partial r} \right) = 0 \Rightarrow \mathcal{L}^2 = \frac{GM}{r^3} , \quad \nwarrow = U(r, l)$$

$$\left( \frac{\partial^2 U}{\partial r^2} \right) = \omega^2 = \frac{GM}{r^3} \quad \mathcal{L} = \omega$$

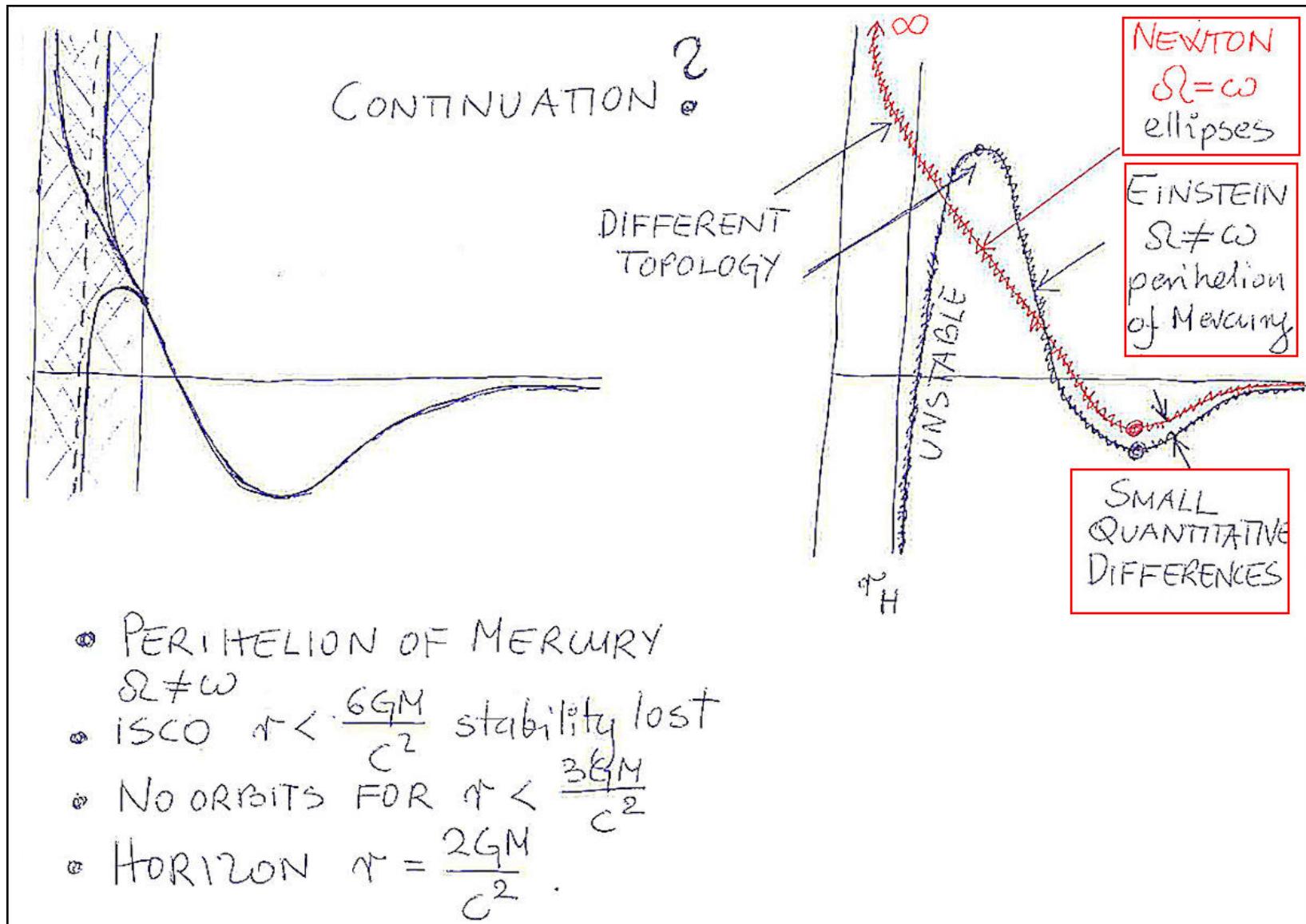
# LIMITS OF APPLICABILITY

(16)



# Guess Einstein

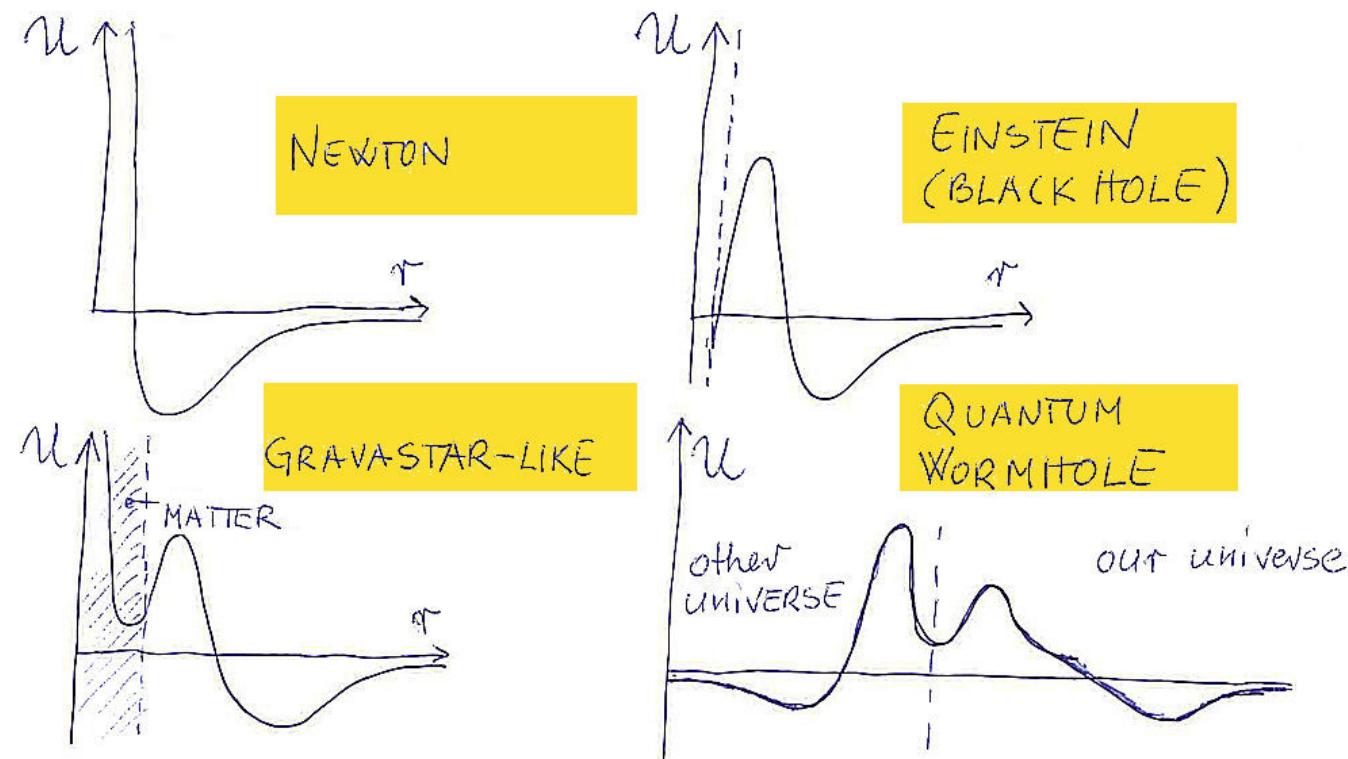
(17)



# Guess quantum gravity

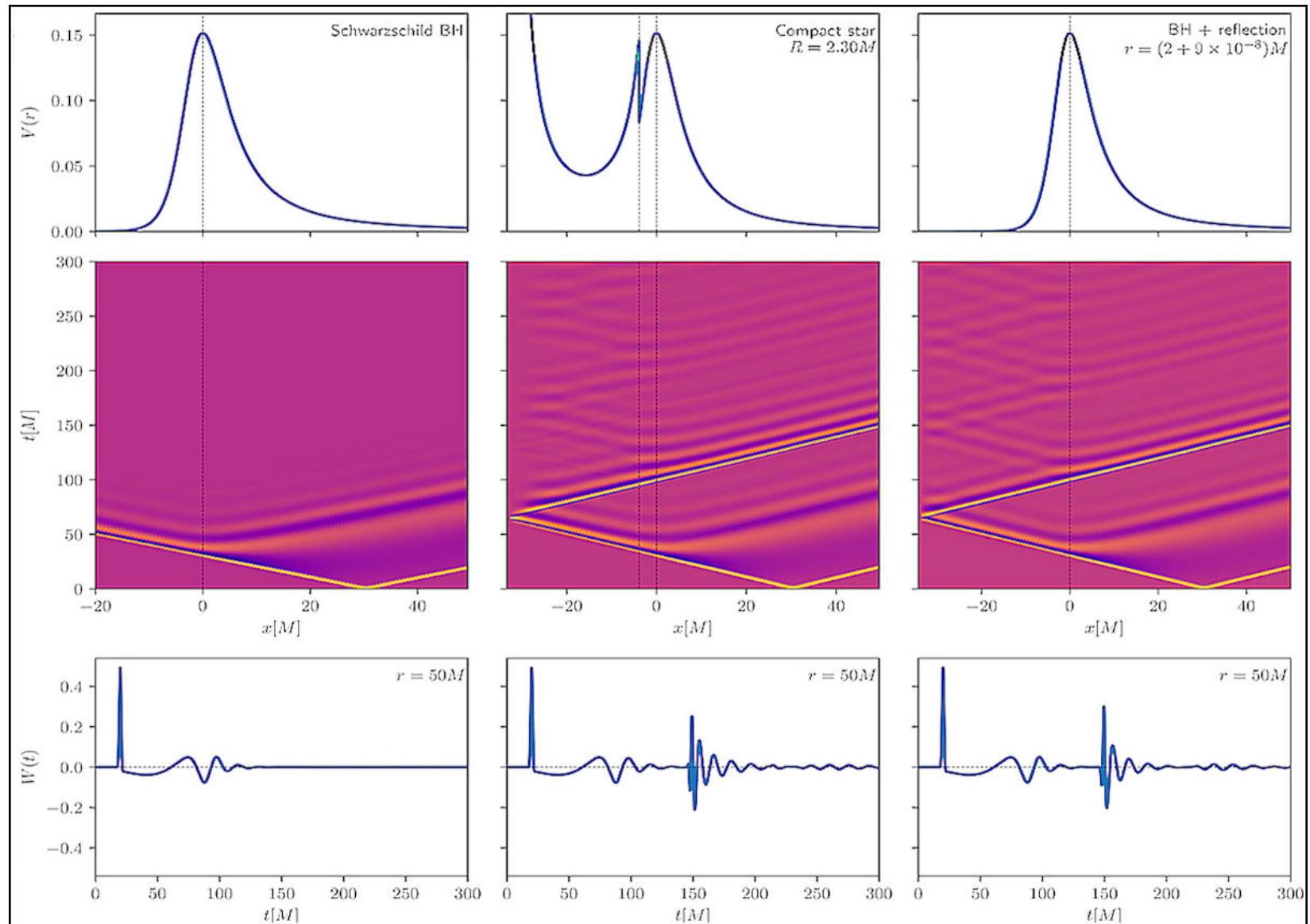
(18)

## QUANTUM ALTERNATIVES TO BLACK HOLES



# Gravitational waves

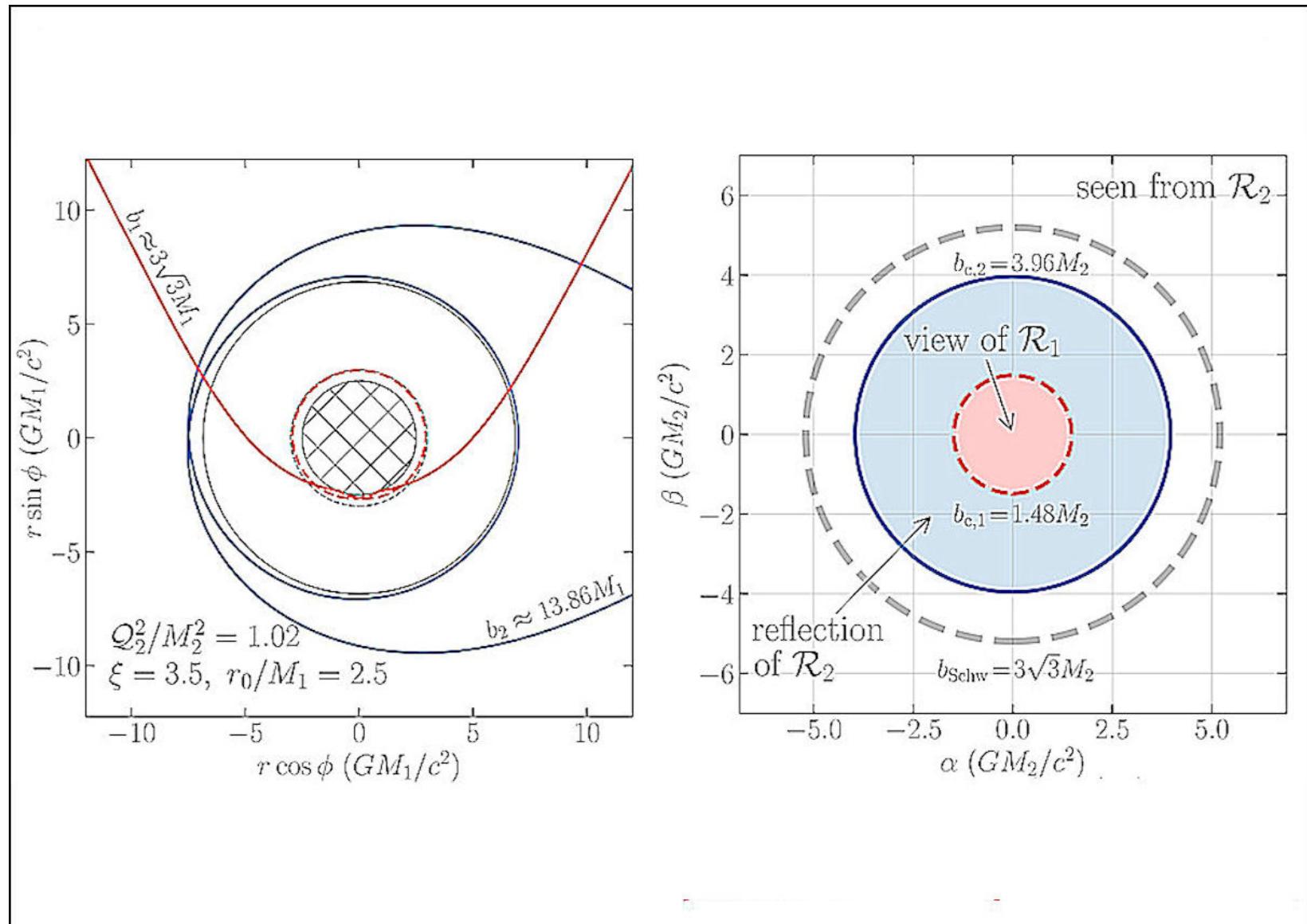
(19)



J.Horak, K.Goluchova, M.A.: Ringdowns and echoes from ultracompact stars

# Secondary rings in the EHT images

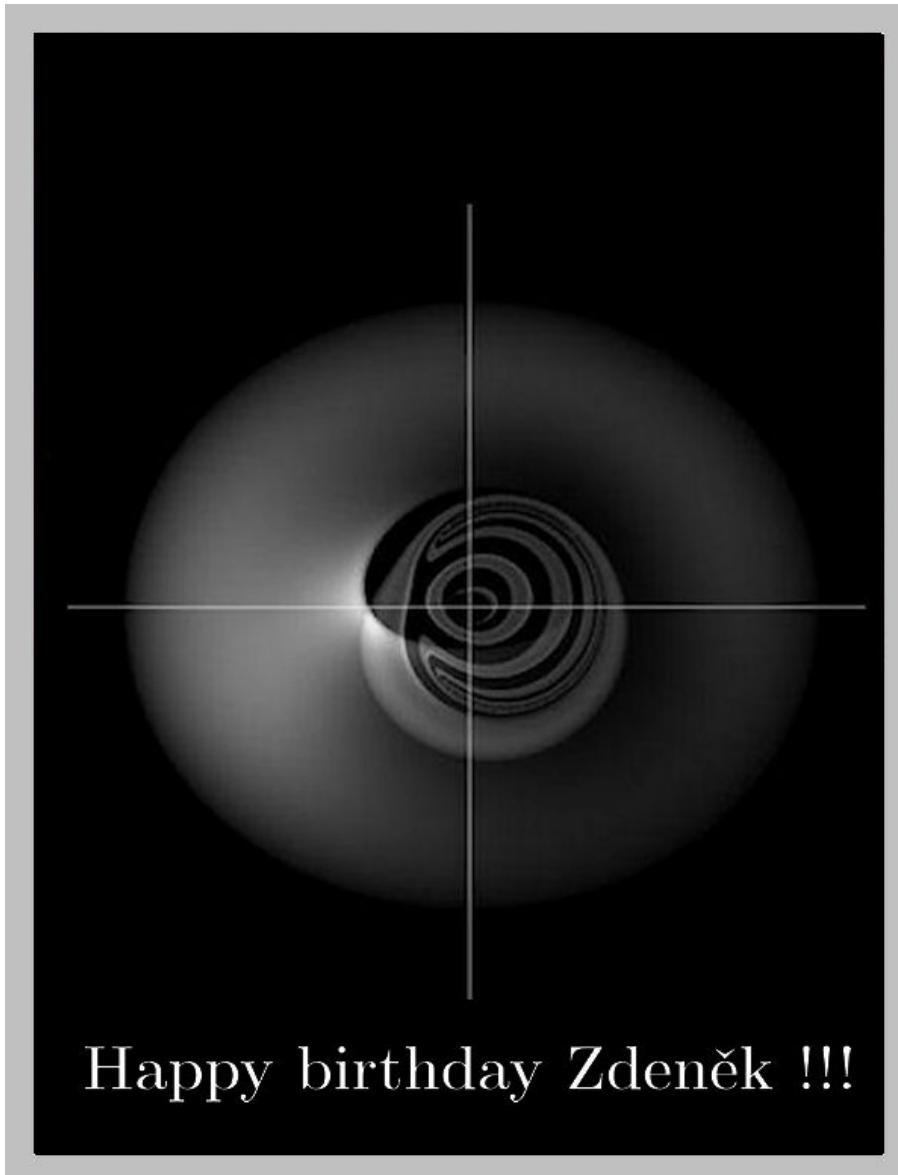
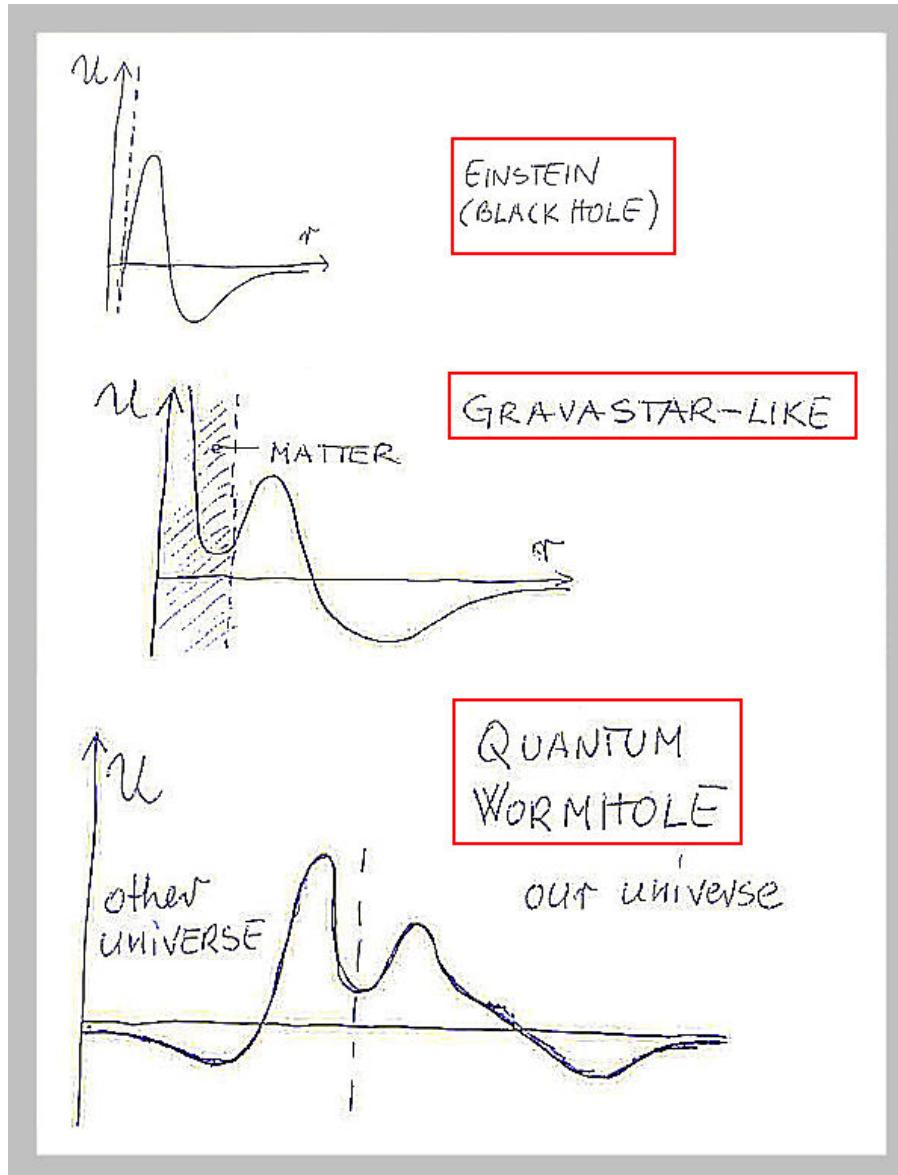
(20)



M.Wielgus, J.Horak, F.Vincent, M.A.: Wormholes

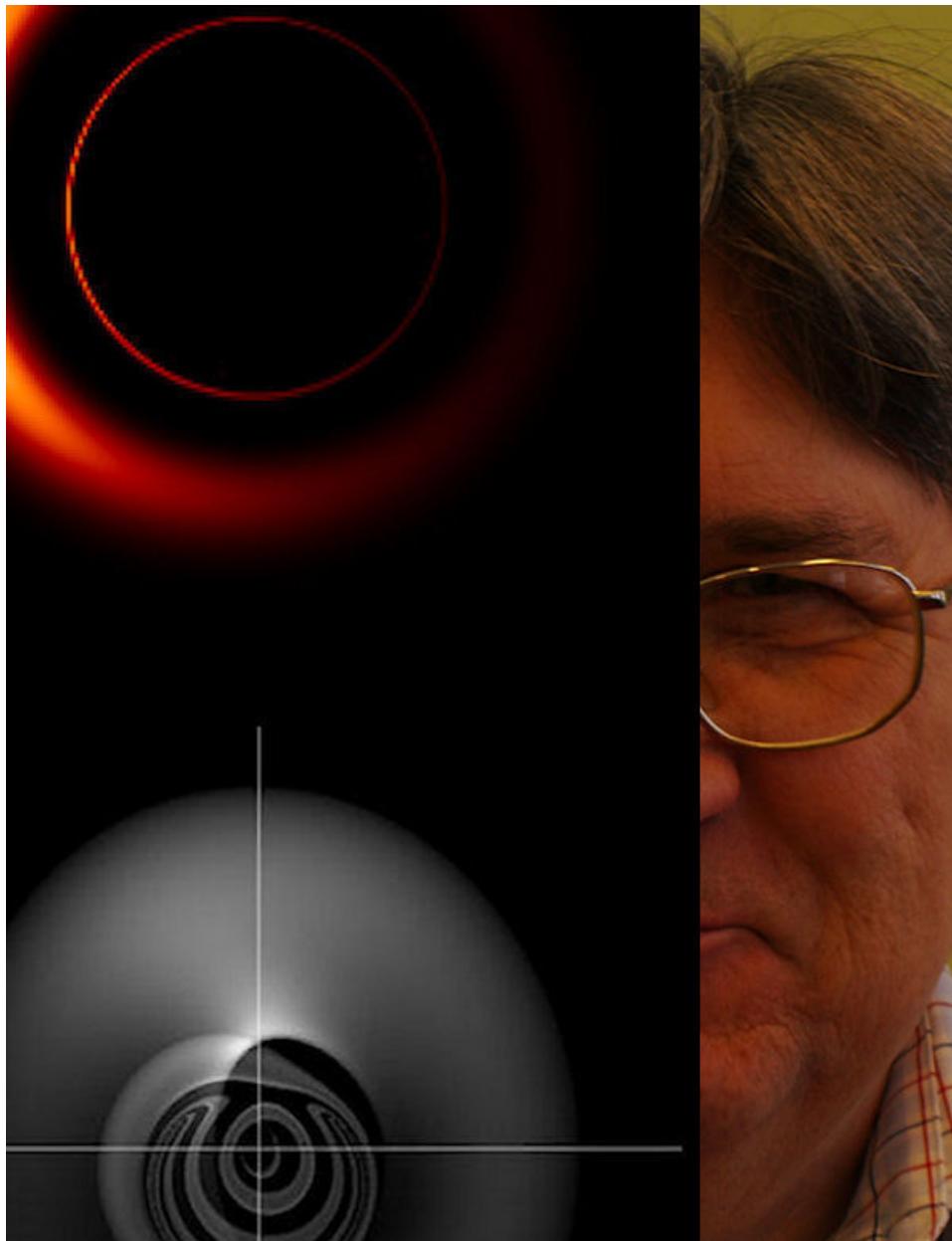
# Final conclusions

(21)



# Content slide by slide

(22)



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01 *Happy Birthday Zdeněk !!!*

1

02 *Zdeněk www page*

2

03 *Silhouettes*

3

04 *Opava 15 yrs ago*

4

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## 1. Our approach: topology

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05 *Covid-19 research*

5

06 *Summary. Conclusions*

6

07 *Newton & Einstein: a reminder*

7

08 *Our approach: exact topology*

8

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## 2. Effective potential in Newton theory

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09 *Newton: conservation of energy and momentum*

9

10 *Newton: effective potential (1)*

10

11 *Newton: effective potential (2)*

11

12 *Newton: effective potential (3)*

12

13 *Newton: almost circular*

13

14 *Newton: epicyclic frequencies*

14

15 *Newton: summary*

15

16 *Newton: limits of applicability*

16

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## 3. Topological guesses and preliminary results

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17 *Guessing Einstein*

17

18 *Guessing Quantum Gravity*

18

19 *Result: QG Ringdowns, echoes*

19

20 *Result: EHT image wormhole*

20

21 *FINAL CONCLUSIONS*

21