RELATIVITY IN MOTION

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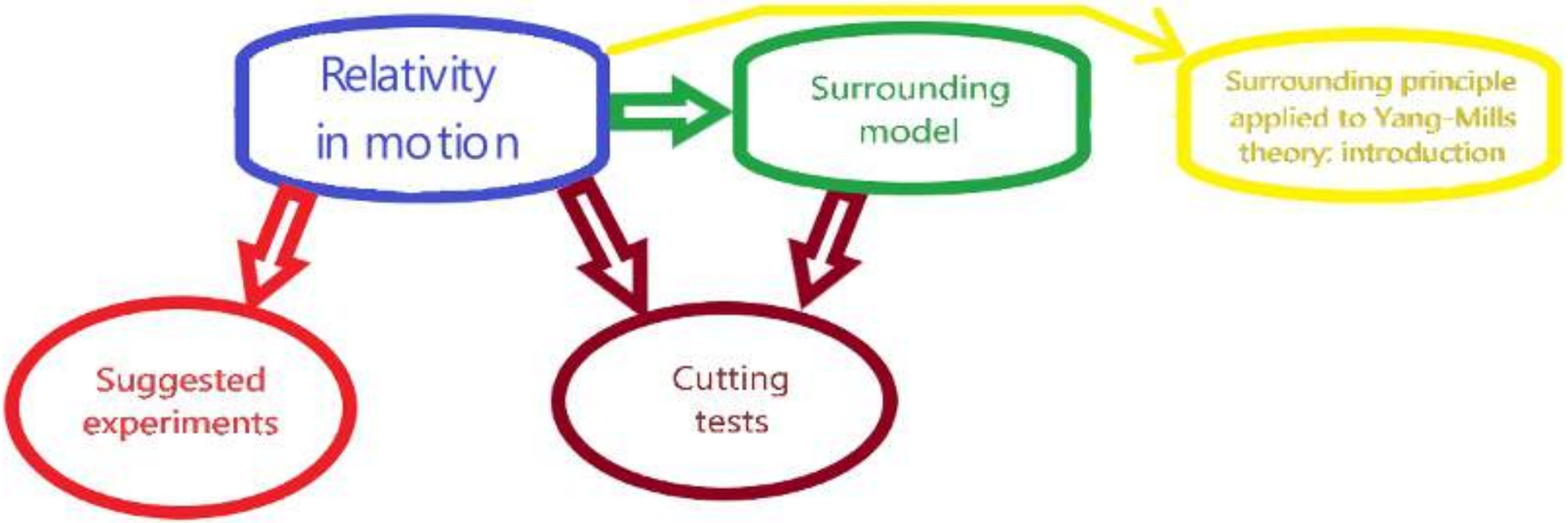
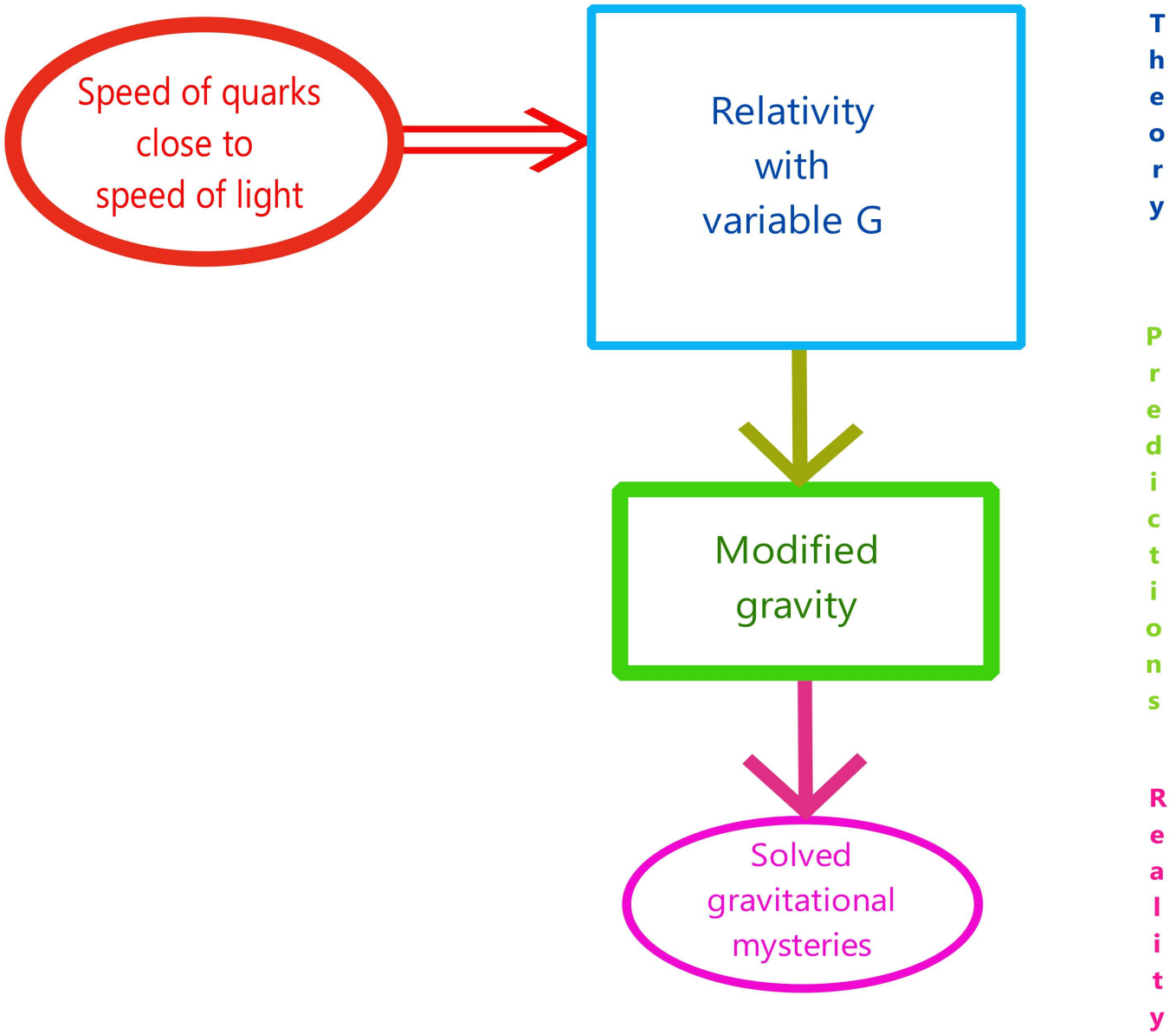
I. Introduction

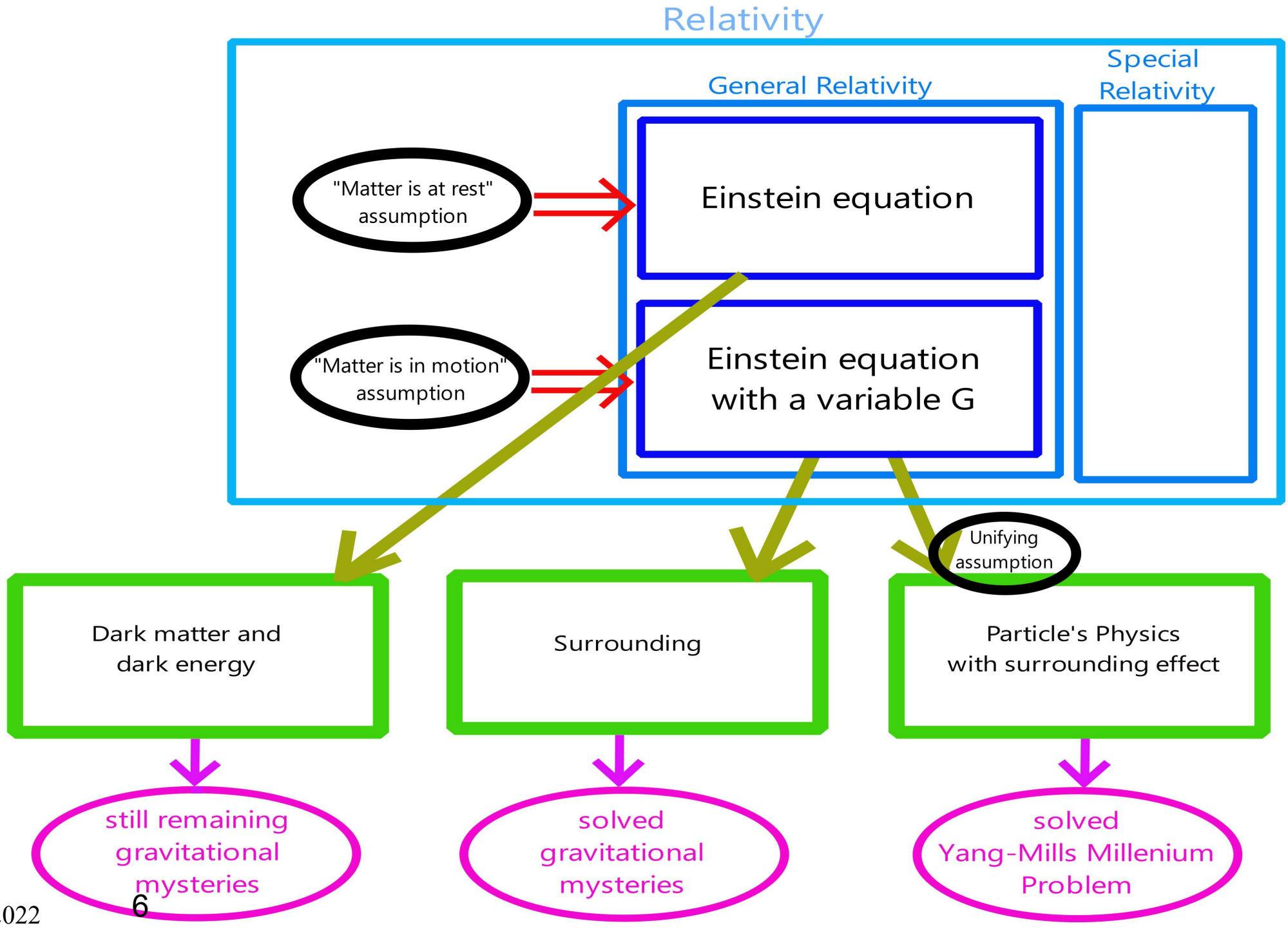
Introduction: the research



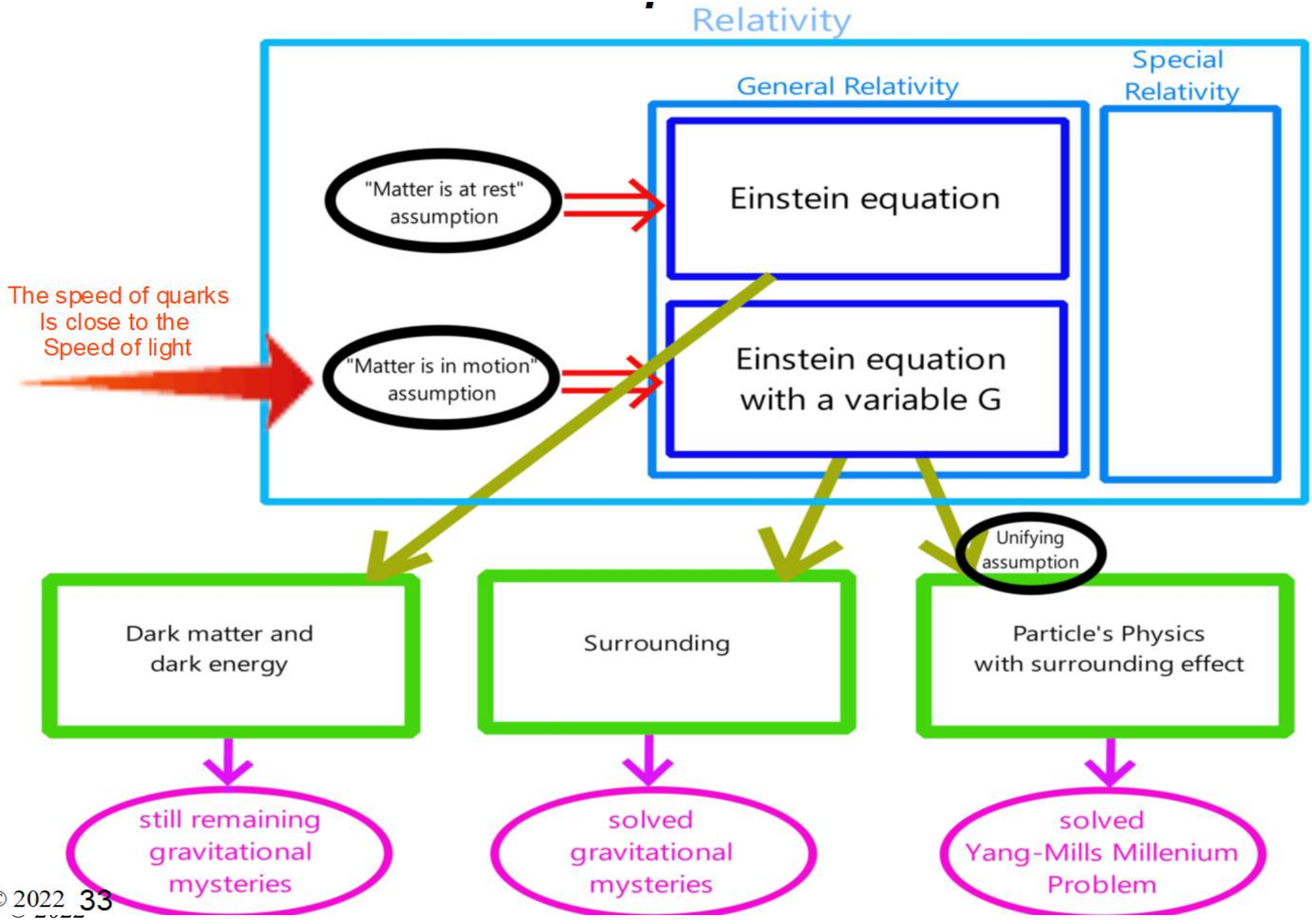
Introduction: principle of the presentation



Introduction: today's presentation



Introduction: today's presentation



II. Motivation

Motivation

Possible caveats in relativity :

- Scale variation of Einstein equation
- Mach's principle
- Loss of information in a stress-energy tensor
- Retardation of gravitational interaction
- Speed of quarks not taken completely into account

Motivation (following)

General Relativity established in 1916

Quarks discovered in 1968.

- Speed > 0,99 c

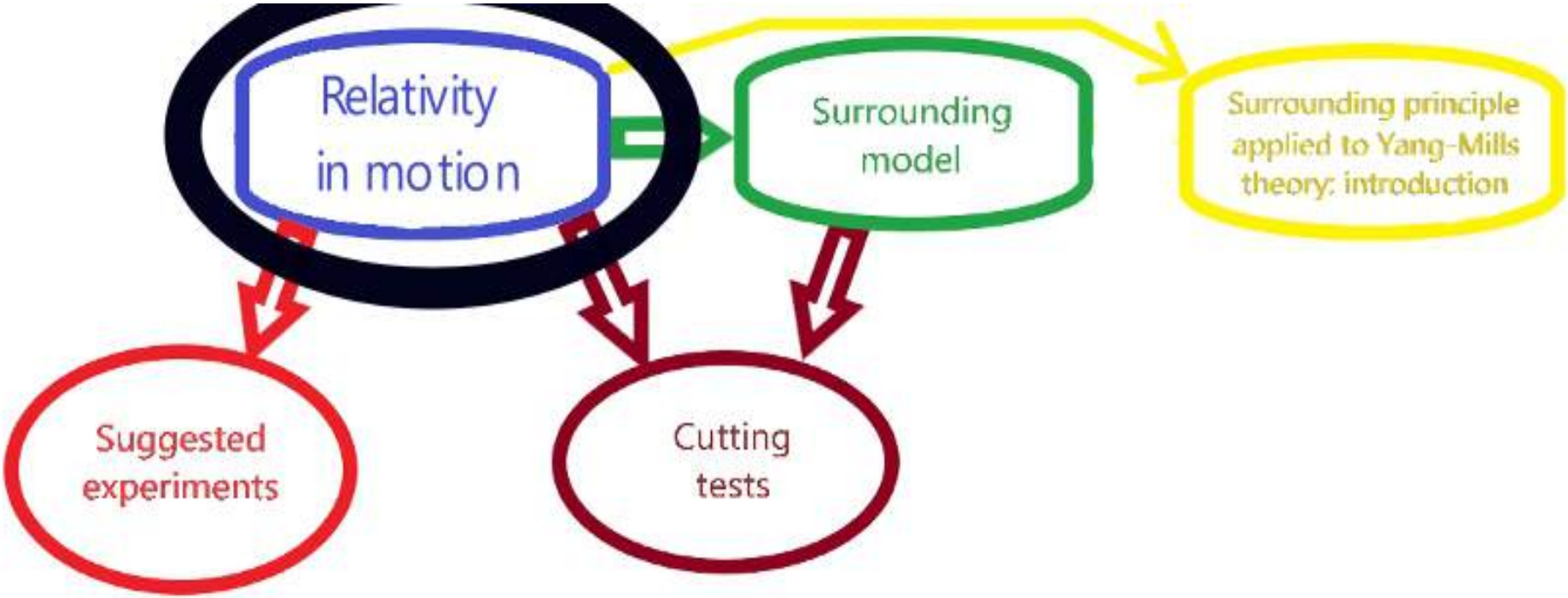
  assuming that their kinetic energy is part of QCD binding energy

Speed of quarks taken into account ?

- Wikipedia about quarks :

  « Gravitation is too weak to be relevant to individual particle interactions except at extremes of energy (Planck energy) and distance scales (Planck distance). However, since no successful quantum theory of gravity exists, gravitation is not described by the Standard Model. »
- Therefore no consequences in particle physics : of course !
- BUT what about their gravitational waves in General Relativity !?

III. Relativity in motion



Correction

Let's take into account the speed of quarks

- $E = mc^2$ => baryon mass contains quarks energy of motion
- NOT THE END OF THE CONSEQUENCES
  - Quarks generate microscopic gravitational waves (GW)
    → Space-time is full of such GW !

So what ?

- Retardation of gravitational interaction
- Cumbersome calculations in GR . . .

→ Let's search for a <u>simpler equation in GR</u>

Searching for a simple equation : Reminders about GR

First reminder : privileged frame of relativity

- Frame in which time elapses the most
- Generalization: frame in which there is matter attached to
- Interpolation: the privileged frame

Second reminder : boost transforming the privileged frame

A particle in motion at the *v* speed in a Minkowskian flat space-time gets a ***four momentum***

$$D^{\mu}(x) = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\frac{E}{c}\left(1, \frac{v_x}{c}, \frac{v_y}{c}, \frac{v_z}{c}\right)$$

from which is deduced the *boost* describing the local space-time deformation

$$B_{\nu}^{\mu}(x) = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \begin{matrix} 1 & -v_x/c & -v_y/c & -v_z/c \\ -v_x/c & 1 & 0 & 0 \\ -v_y/c & 0 & 1 & 0 \\ -v_z/c & 0 & 0 & 1 \end{matrix}$$

Resulting « simple » equation

Resulting equation relating energies of the microscopic gravitational waves :

Equation:

$$D^{\mu}(x) = \sum_{n=0}^{\infty} \delta(\|x - y_n\|_3 - x^0 + y_n^0) f(\|x - y_n\|_3) C^{\mu}(y_n)$$

where :

$$D^{\mu}(x) = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \frac{E}{c} \left(1, \frac{v_x}{c}, \frac{v_y}{c}, \frac{v_z}{c}\right)$$

$$C^{\mu}(y_n) = \frac{E(y_n)}{c} \left(1, \frac{c_x}{c}, \frac{c_y}{c}, \frac{c_z}{c}\right)$$

Now, from

$$D^{\mu}(x) = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \frac{E}{c} \left(1, \frac{v_x}{c}, \frac{v_y}{c}, \frac{v_z}{c}\right)$$

Then the boost is deduced

$$B_{\nu}^{\mu}(x) = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \begin{matrix} 1 & -v_x/c & -v_y/c & -v_z/c \\ -v_x/c & 1 & 0 & 0 \\ -v_y/c & 0 & 1 & 0 \\ -v_z/c & 0 & 0 & 1 \end{matrix}$$

and the evolution of the metric

$$g_{\alpha\beta}(x) = B_{\alpha}^{\rho} B_{\beta}^{\kappa} S_{\rho}^{\mu} S_{\kappa}^{\nu} g_{\mu\nu}(x')$$

Features of this equation

Equation:

$$D^{\mu}(x) = \sum_{n=0}^{\infty} \delta(\|x - y_n\|_3 - x^0 + y_n^0) f(\|x - y_n\|_3) C^{\mu}(y_n)$$

This equation is an approximation of what is going on in GR :

- Mean space-time structure is given by this equation (...)
- This equation is
  - scalable,
  - does not use the *G* constant,

How to calculate

Different ways to calculate what is going on in GR:

- Using the simple equation relating GW energies,
- Using Einstein equation and the value of *G* given by:

$$G_{new\ case} \simeq G_{solar\ system} \left(\frac{\sum_{n=0,solar\ system}^{\infty} 1_w(x, y_n) \sqrt{\frac{C^0(y_n)}{\|x-y_n\|_3}}}{\sum_{n=0,new\ case}^{\infty} 1_w(x, y_n) \sqrt{\frac{C^0(y_n)}{\|x-y_n\|_3}}} \right)^2$$

Surrounding behaviour : equivalent G is inversely proportional to the surrounding energy at the loction where the force is exerted

- Using GR lagrangian in vaccum for any complicated case.

Back to motivation

The possible caveats of relativity mentionned above are solved:

- Scale invariance solved
- Mach's principle solved
- Loss of information in a stress-energy tensor solved
- Retardation of gravitational interaction solved
- Taking into account properly the speed of the quarks solved

Consequence in gravitation

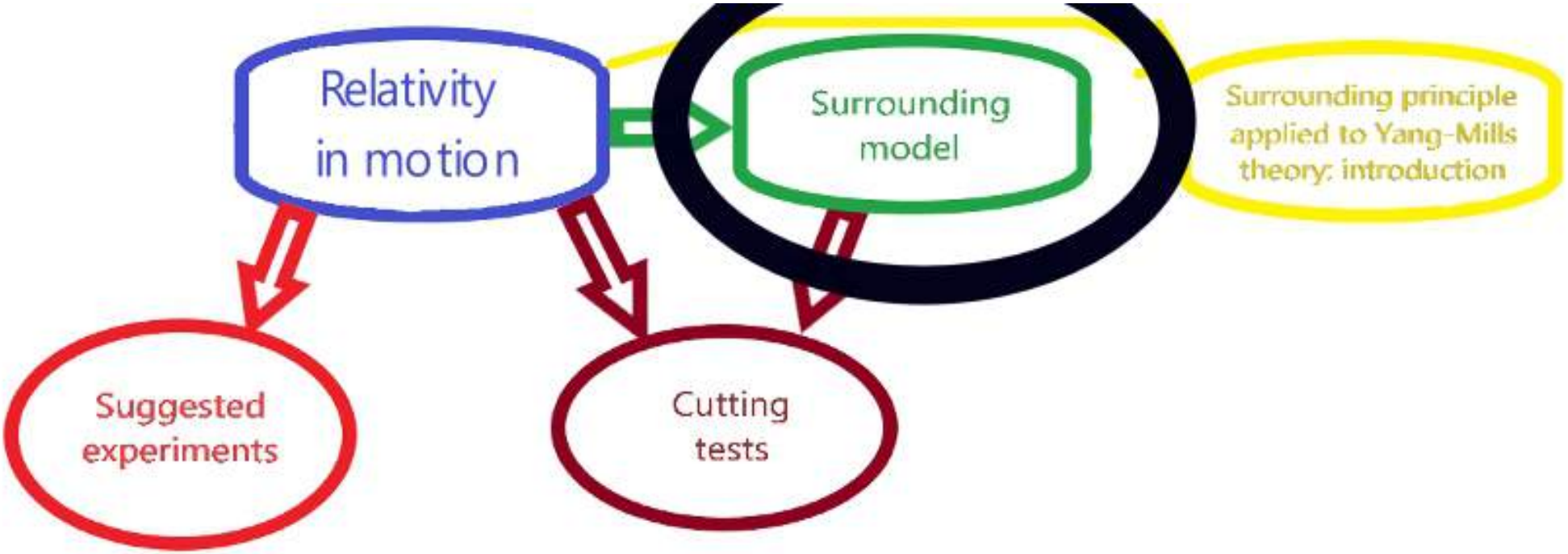
- This correction implies → microscopic scale
- Gravitation → macroscopic scale

  Many ways of constructing a gravitational model with **surrounding behaviour:**

  - Shape of the surrounding ?

    → a 15 kpc ray sphere with a door profile

IV. Surrounding



Surrounding non relativistic equation of motion

$$\Phi = -\frac{MG}{x}\frac{\alpha_0\rho_0 + \rho_{u0}}{\alpha\rho + \rho_u} \quad , \qquad \leftarrow \text{an « equivalent G » arises}$$

with $\alpha = \alpha_0 = 1.6\,10^{-5}$ inside of galaxies,

and $\alpha = 1$ outside of any galaxy.

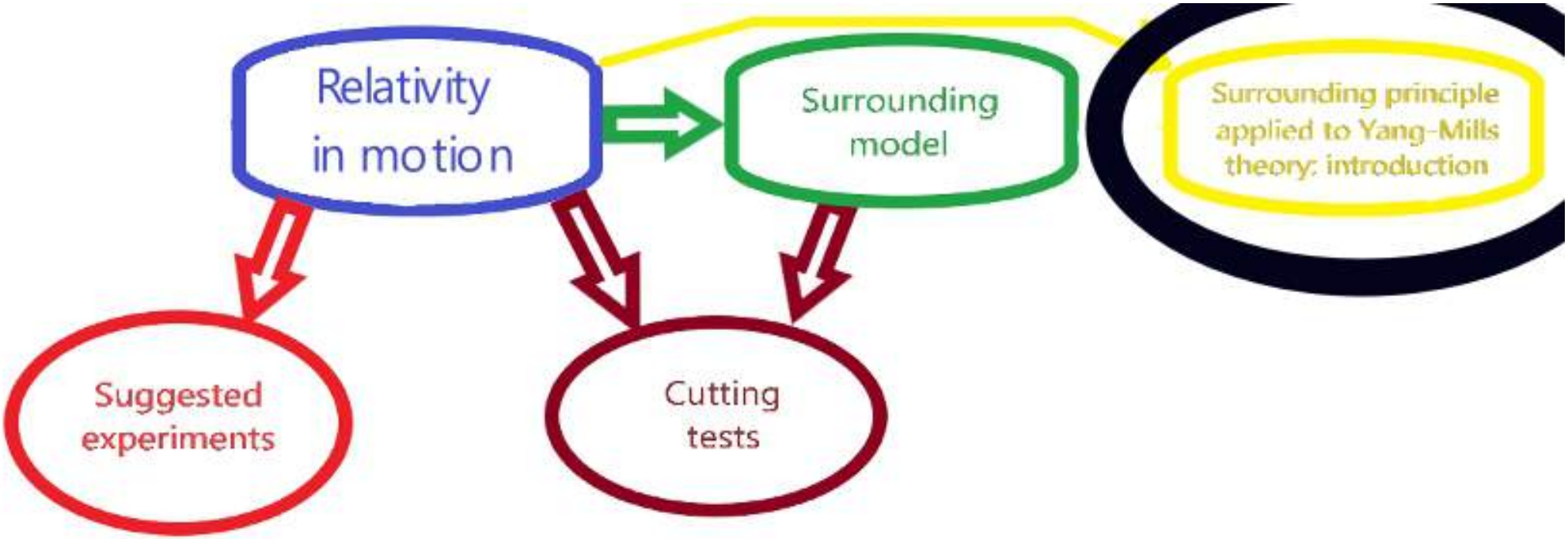
Surrounding

Appears to solve the following gravitational mysteries:

- Galaxy cluster virial theorem
- Galaxy speed profiles
- Ring galaxies
- Dwarf galaxies
- Bullet cluster
- Large scale structure
- Cosmology: exponentional (« de Sitter »...) universe : acceleration of expansion q=-1, space curvature k=0, fine tuning, horizon, age of the universe 100 Gyr
- Upper limits of matter densities
- Tully-Ficher law
- ...

galaxy structure using Surrounding

V. An insight into particle physics

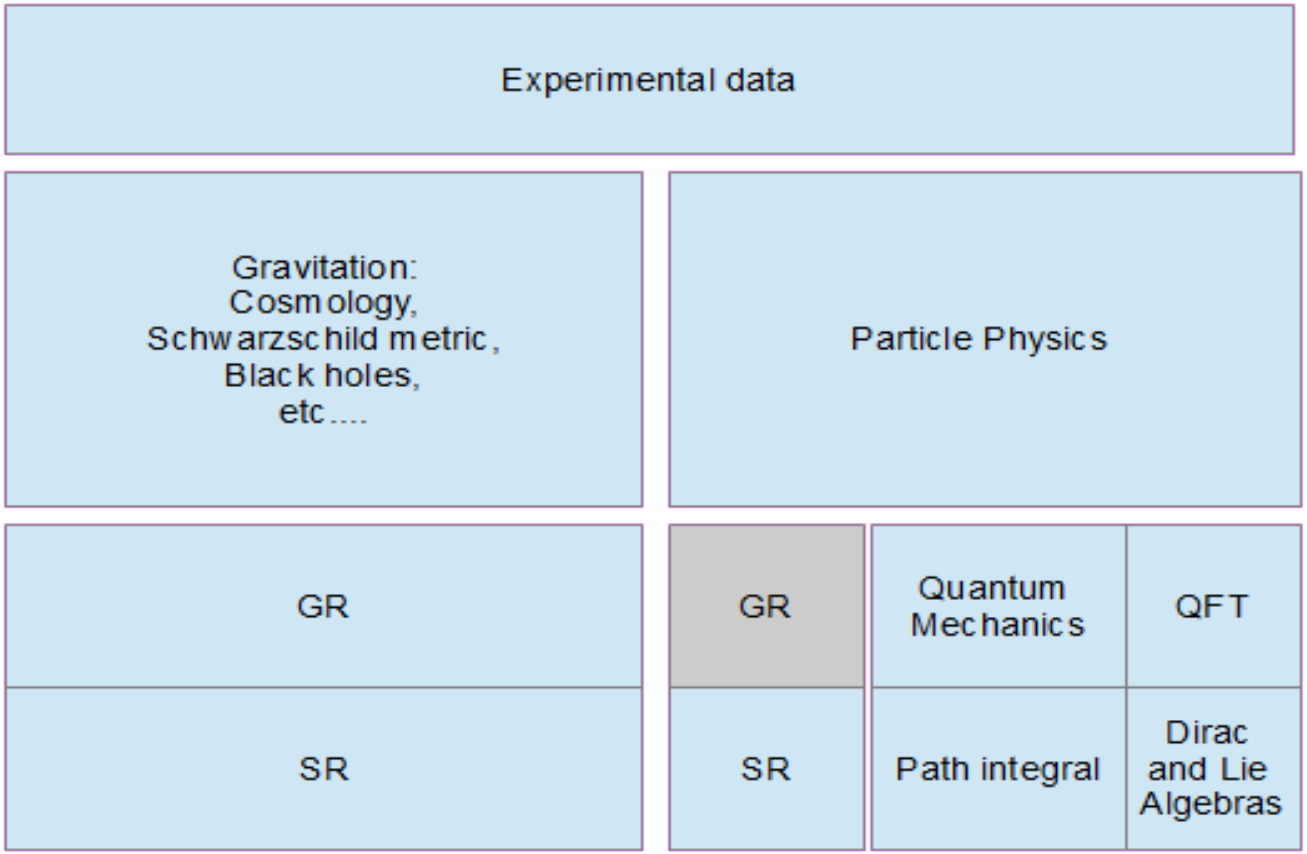


Assumption required for particle physics

The four forces are unified by gravity

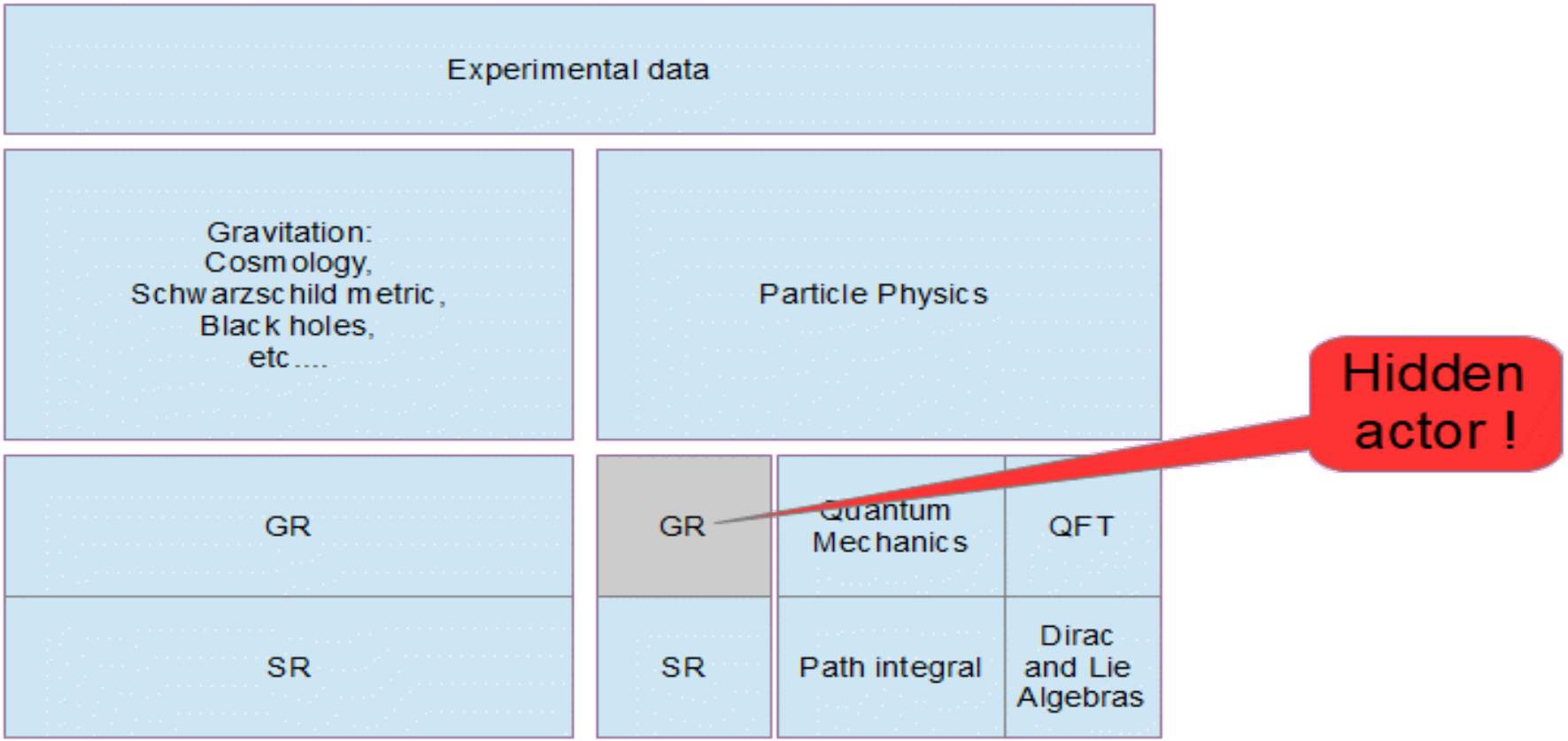
Consequence of those two assumptions in particle physics

- Reminder of today's picture :



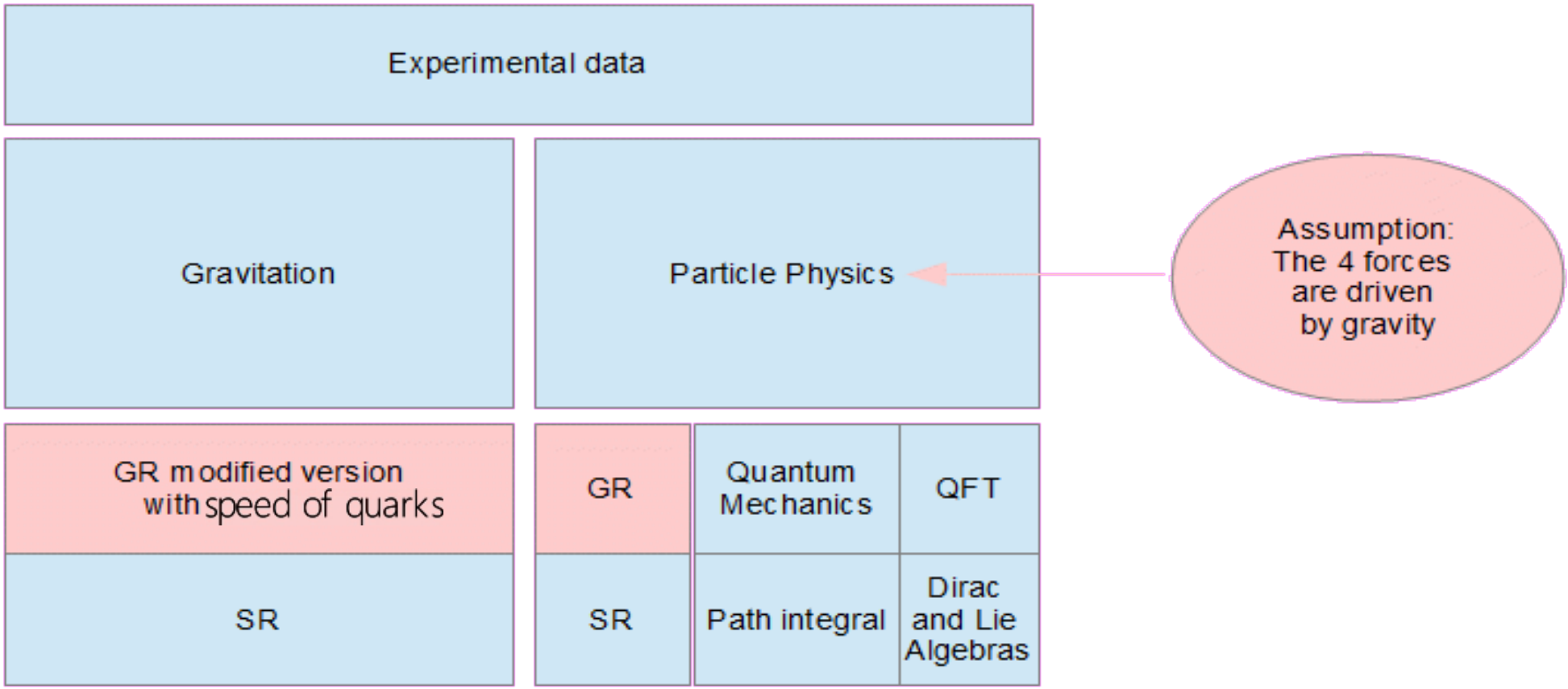
Consequence in particle physics

- The today's picture contain a **hidden actor**:



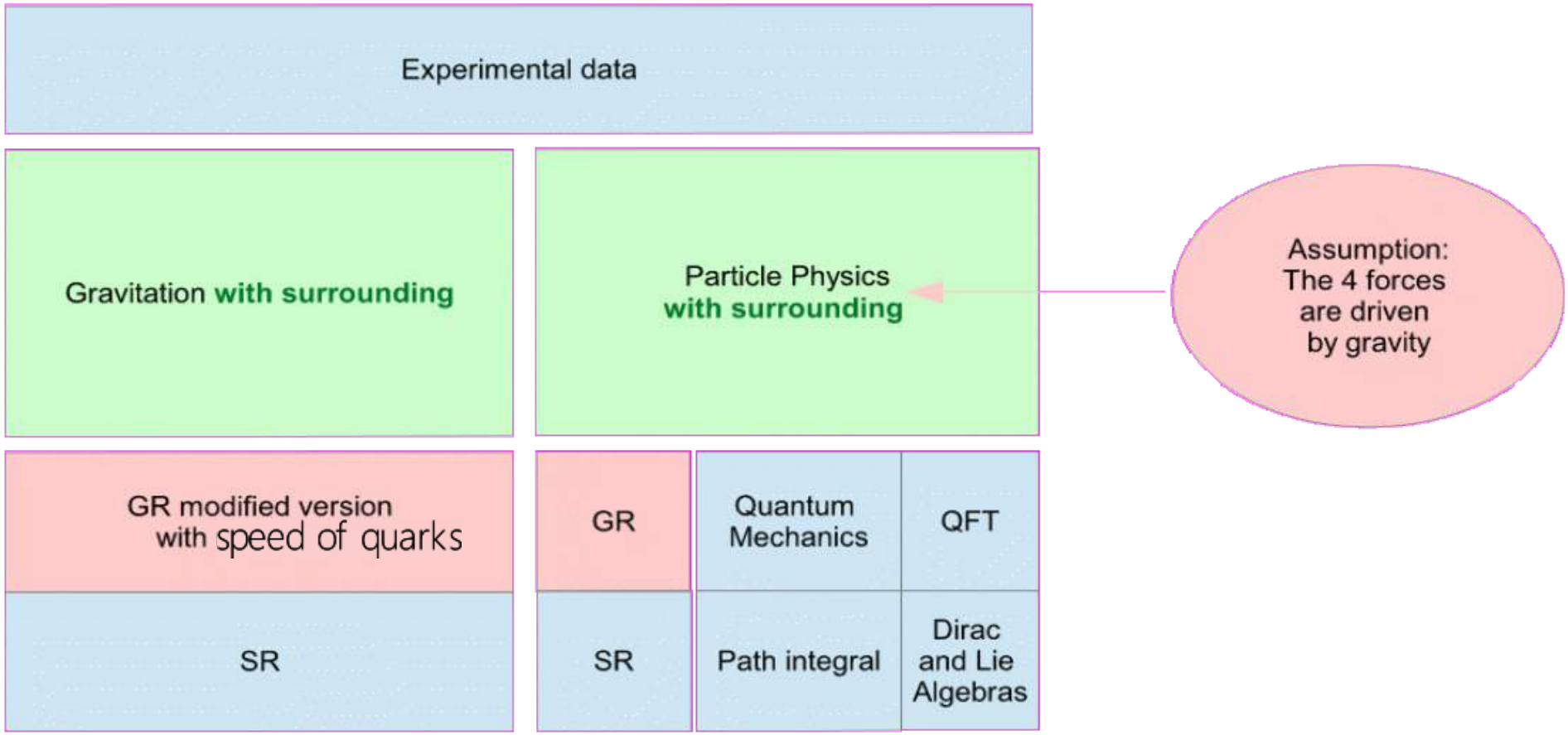
Consequence in particle physics

- **2 modifications :**



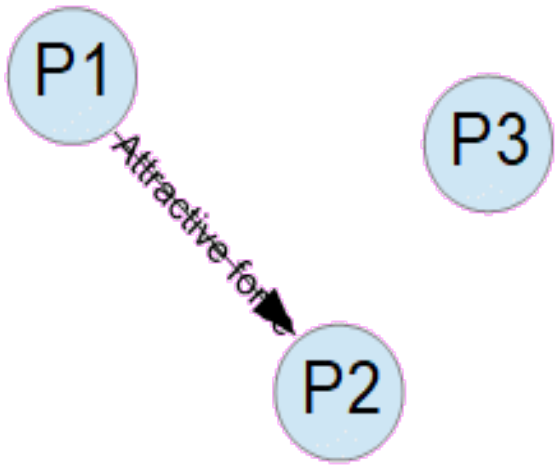
Consequence in particle physics

- **Consequences**



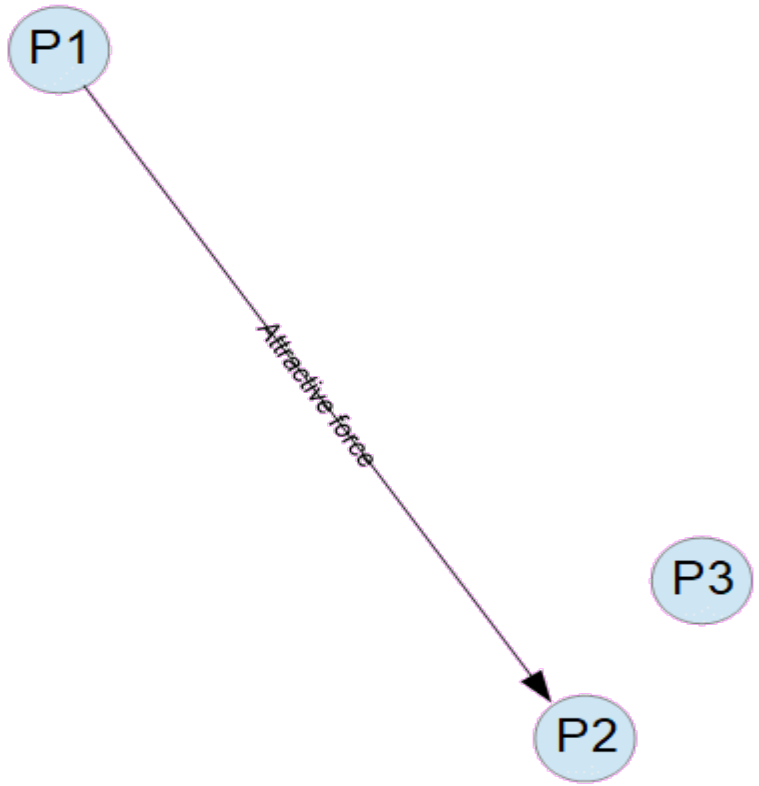
Consequence in particle physics

- Attractive force from P1 to P2 is weak because P3 is in the surrounding of P1



Consequence in particle physics

- Attractive force from P1 to P2 is stronger because P3 is no longer in the surrounding of P1



Consequence in particle physics. Modification in the calculations

- The surrounding factor multiplies ***g***, the coupling factor

$\mathcal{L}_{\text{gf}} = -\frac{1}{2}\,\text{Tr}(F^2) = -\frac{1}{4}F^{a\mu\nu}F^{a}_{\mu\nu}$ unmodified $(D^\mu F_{\mu\nu})^a = 0.$ unmodified

$D_\mu = I\partial_\mu - igT^a A^a_\mu,$ **Modified because *g* is modified** $(D^\mu F_{\mu\nu})^a = 0.$ unmodified

$F^a_{\mu\nu} = \partial_\mu A^a_\nu - \partial_\nu A^a_\mu + g f^{abc} A^b_\mu A^c_\nu$ **Modified because *g* is modified**

- What remains to describe is this surrounding energy:
  - *ray R of the sphere ? R<nucleus_ray, but what more ?*
  - *Shape of the surrounding sphere (window, triangular, cos² shaped) ?*

Must be fitted to experimental data :

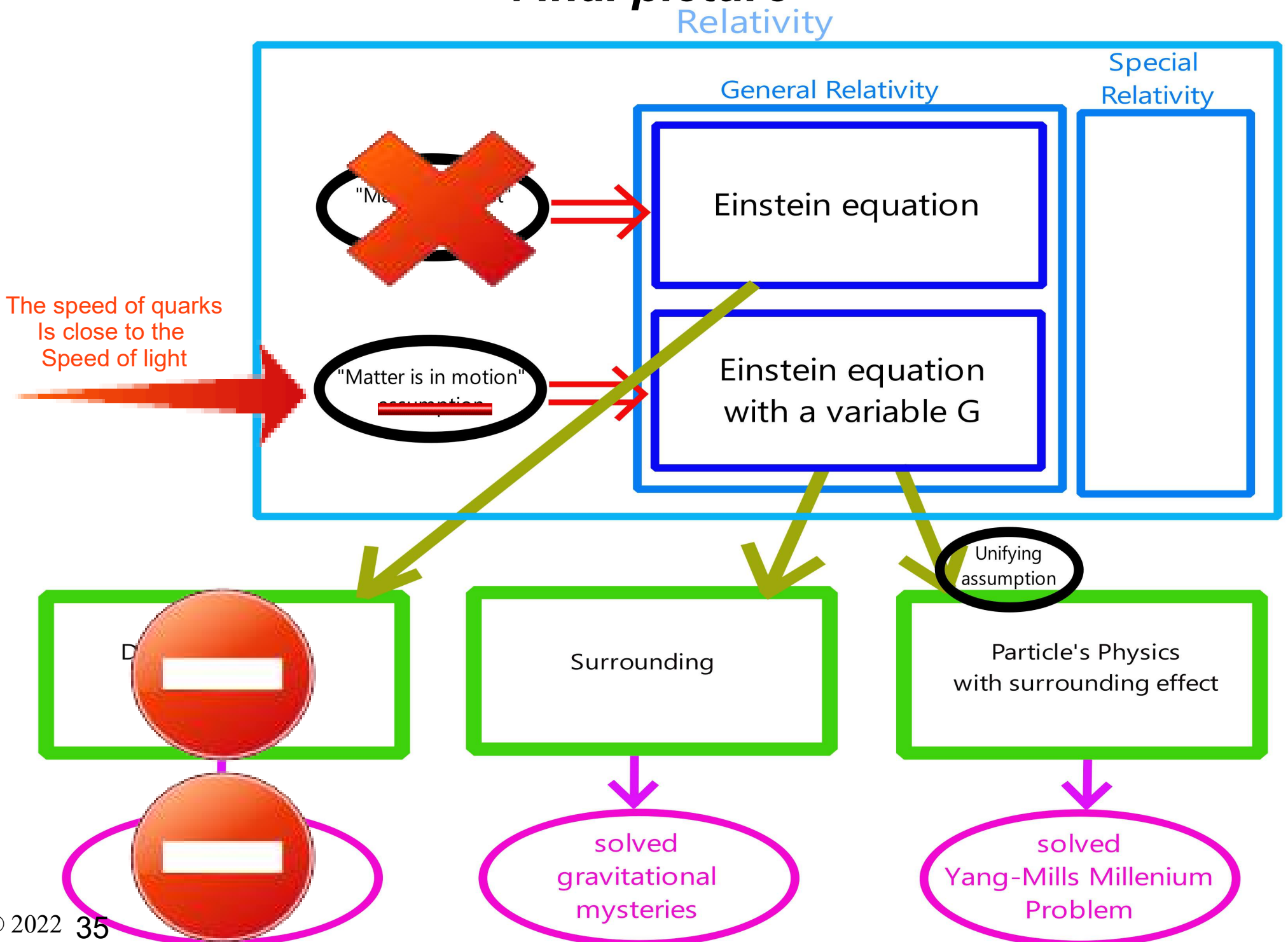
- The ray of a windowed sphere first
- Then more complicated things if required

Consequence in particle physics : testing and validation ?

- Triple nuclear collisions :
  - almost impossible to realize !
- Validation of the model :
  - Creation of a dedicated experiment
    - Variation of the Planck Constant
    - Collective behaviour in the nucleus
    - …
  - Unexplained experimental data
    - QCD color confinement, but also :
    - Ay puzzle, saturation of nuclear matter, ...
    - Resonance of nucleus
    - Proton radius puzzle
    - ...

VI. Final picture

Final picture



VII. Next to come

Discussions and criticisms with theoretical physicists

- Historically how did this underestimation of quark speed consequences happened ?
- Why such an oversight could happen ?

Testing the Surrounding effect in collaboration with experimental physicists:

- Astrophysical scale : testing Surrounding,
- Microscopic scale : testing the surrounding effect in particle physics

VIII. Conclusion

Detailed conclusion

The speed of quarks must be handled specifically

The cumbersome calculations in GR are handled by :

- Conservation of GR lagrangian in vaccum when calculations are possible.
- Einstein equation using *G* value given by an energy equation in either cases.

Result:

- For gravitation, → **Surrounding** (Surrounding gravitational model) :

  appears to solve the « dark matter and dark energy » mysteries

- For Particle Physics, <u>under a unifying assumption</u>:

  → **suggests a solution to the Yang-Mills Millenium Problem**

Synthetic conclusion

Today, energy of motion inside matter is discarded.

But FACT: energy of motion is far greater than energy at rest

Speed of the quarks.

$E = mc^2$ might suggest that this FACT implies no modification

Wrong suggestion

Fixing this mistake:

gravitational mysteries are explained

Millenium Yang-Mills problem is explained under a

ing assumption.

Thank you for your attention !