



# DARK update

**W. M. Bonivento - INFN Cagliari**

On behalf of the DARK Collaboration

Runione Nazionale Referenti CC3M

## **Tematiche relative alla sigla**

Quando la sigla e' stata aperta (2020):

**DARK MATTER e DARK ENERGY**

Ora abbiamo espanso lo scopo a:

**COSMOLOGIA, STORIA DELLA GRAVITA', RELATIVITA SPECIALE E  
GENERALE, BUCHI NERI, ONDE GRAVITAZIONALI, QUANTUM GRAVITY  
CONNESSIONI FILOSOFICHE**

**Progetto multiennale itinerante**

## **Le attività' di DARK spiegate dal nuovo sito web**

<https://dark.infn.it>

creato da Valerio Ippolito (Roma1)

da linkare nel nuovo sito della CC3M

# Assegnazioni CA 2022

Sigla Loc.	Capitolo	Riunione	Note Alla Richiesta	Rich.	Rich. SJ	Assegn.	Assegn. SJ	Assegn. Dot.	Commento Alla Assegnazione
CA	MISS	Assegnazioni	spostamento responsabile nazionale Â§	1.0	0.0	1.0			
		Assegnazioni	missioni per Dark Matter day a LNGS 3 personeÂ§	1.0	0.0	0.5	0.5		
		Assegnazioni	missione festival Â§	1.0	0.0	0.0	0.5		SJ effettiva necessità, ridotta per esigenze di bilancio
		Totale MISS			3.0	0.0	1.5	1.0	0.0
	CON	Assegnazioni	volantini per masterclass, festival gravitasÂ§	0.5	0.0	0.0			
		Assegnazioni	affitto auditorium per festival (e.g.Ghetto Ebrei Cagliari per edizione 2022 Marzo-Aprile)Â§	4.0	0.0	1.0	3.0		ridotta per problemi bilancio, parte sj all'effettivo svolgimento ed alla possibilita' di svolgere ò'evento in luogo piu' economico
		Maggio	Richiesta di sblocco sj	2.0	da sj 2.0	2.0	da sj 2.0		Det. n. 50-8/6/2022
		Totale CON			6.5	-2.0	3.0	1.0	0.0
Totale CA			9.5	-2.0	4.5	2.0	0.0		

# NDMS: talk a conferenze e questionario di valutazione



When physics meets philosophy again: the Gravititas Project



Matteo TUVERI (1) (2), Viviana FANTI (1) (2), Walter BONIVENTO (1)

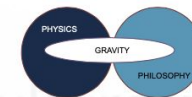
(1) Istituto Nazionale di Fisica Nucleare, Sezione di Cagliari, Cittadella Universitaria di Monserrato, SP per Sestu km 0,700, Monserrato (Italy)

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## Conceptual framework

Gravity is, by far, one of the scientific themes that have most piqued the curiosity of scientists and philosophers over the centuries. From Aristotle to Einstein, from Hawking to now on, scientists and philosophers have always put a creative effort to solve the main puzzles of the understanding of our universe. When they met, a new conceptual revolution has started.

Since Einstein's relativistic theories and the advent of quantum mechanics, physicists and philosophers have taken different paths, both kidnapped by the intrinsic conceptual and mathematical difficulties inherited by their studies. Is it possible to restore a unitary vision of knowledge, overcoming the scientific-humanistic dichotomy that has established itself over time? The answer is certainly not trivial, but we can start from school to experience a new vision of a unified knowledge. From this need, the "Gravititas" project has born.



## The study

**Participants:** 250 students (m=128, f=108) from 16 high schools in Sardinia (111 from scientific, 9 from «humanities», 7 from artistic high schools) subscribed to the project (n=43 were 19 yo; n=130, 18 yo; n=63, 17 yo). 127 students (m=72, f=75) wrote the posts and completely ended the project. The mean number of visualization per Youtube video is around 350

**The research:** we wrote a research questionnaire to investigate items such as motivation (in physics and philosophy), the learning process of contents during «Gravititas», the influence of the project on students' interest towards topics of the project and students' feelings about a possible implementation of Gravititas methodology in schools.

Students could answer by using a 6-points Likert scale, from 1 (completely disagree) to 6 (completely agree).

### Research questions:

- monitoring students' motivation towards physics and philosophy on specific items
- how the project can influence students' perception on physics and philosophy, science communication and students' interest in these three fields
- Investigation about students' feelings on the possibility to bring the Gravititas' format and contents also to school

**The sample:** we collect 70 answers (m=42, f=28)

**Analysis:** qualitative analysis (means and standard deviation) and analysis of variance (ANOVA) based on gender (not shown here). Answers are shown in Figs. 2-8 (where not specified, the y-axis shows the 6-points Likert scale cited above).

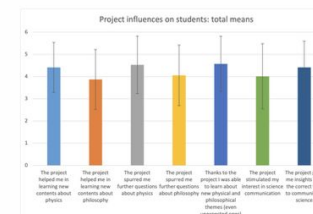


Fig. 2 The panel shows the means related to the influence the project has had on students about physics, philosophy and science communication. Error bars are the standard deviation.

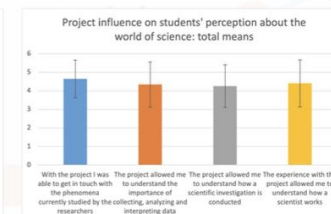


Fig. 3 The panel shows the means related to how the project influence students' perception of the world of science. Error bars are the standard deviation.

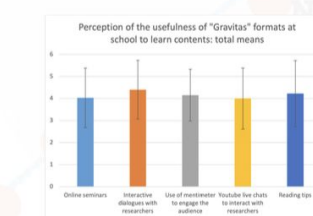


Fig. 4 The panel shows the means related to the perceived usefulness of «Gravititas» format in class to learn contents. Error bars are the standard deviation.

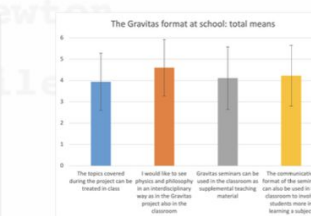


Fig. 5 The panel shows means related to students' perception about including some Gravititas' format in class. Error bars are the standard deviation.

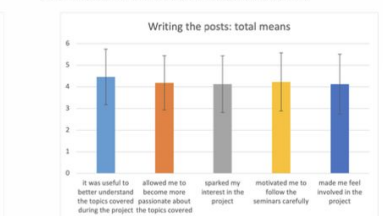


Fig. 6 The panel shows means related to students' feeling on writing the posts. Error bars are the standard deviation.

## Conclusions and future studies

The project had a positive influence on students' motivation towards physics, philosophy and science communication (means related to physics are higher than the others). They also felt motivated to actively participate to the project and its activities (see Fig. 7). Finally, students really appreciate the project (see Fig. 8).

**Ongoing activities:** study of the data coming from items on motivation in physics and philosophy and data coming from the ANOVA on gender. Organization of the festival together with students

### Future purposes and investigations:

- Extend the audience to all Italy in next years
- Analyse data from a specific questionnaire devoted to teachers who participated at the project

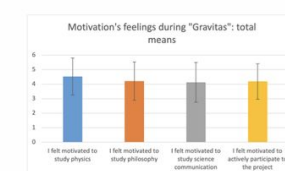


Fig. 7 Students' motivation in specific topics while they were attending the project. The ranking scale goes from 1 (completely disagree) to 6 (completely agree). Error bars are the standard deviation.

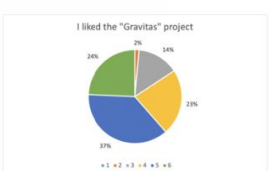


Fig. 8 Students overall perception of the project. The ranking scale goes from 1 (completely disagree) to 6 (completely agree).

## The «Gravititas» Project

«Gravititas» is a **multidisciplinary outreach and educational program** devoted to high school students (17-19 years old) that mixes contemporary physics and the philosophy of science. Coordinated by the Cagliari Section of the National Institute of Nuclear Physics, in Italy, it started on December 2021 with an unconventional online format (live on Youtube): two researchers coming from different fields of research (physics vs philosophy, history of science, scientific communication) meet a moderator and informally discuss about the **physics of the 20th century and related conceptual aspects**. The public chats and indirectly interacts with them during the YouTube live or using Mentimeter. The moderator proposes students' question to the speakers or uses them as a theme of discussion during the speech.

The first part of the project ended in April 2022 with a total number of **16 seminars** (see fig 1 for the list of themes discussed) and **32 scientists** coming from all around Europe had been involved.

Students also created contents as **posts aimed for the socials** (such as Facebook and Instagram) inspired by the seminars they attended.

The project will end in September with a **festival** in Cagliari (Sardinia) built in a bottom-up way, that is, starting from students need of knowledge about gravity and related phenomena.

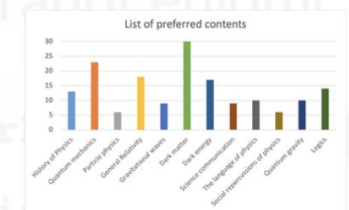


Fig. 1 List of arguments discussed during the online seminars with experts. The panel shows the number of preferences for each content.

## Results and discussion

We show and discuss here results on how the project has influence students' perception on Gravititas' topics (figs 2 and 3); students' perception of the possibility to implement Gravititas' format and topics at school (figs 4 and 5); students' report about their experience in writing posts (fig 6).

For each investigated topic, the Cronbach's alpha is greater than 0.8

Qualitative analysis shows an overall good influence on students attitude towards physics, philosophy and science communication (mean greater than 4), with higher means in physics w.r.t. to the others.

They also appreciated experiencing the Gravititas' format and think that it is exportable even in class, especially for the multidisciplinary approach to mix together physics and philosophy.

They also appreciate writing posts and rate the activity as useful to better understand the topics covered during the project.

GIREP 2022 (Poster)

ICHEP 2022 (Talk)

questionario anche ai docenti (in corso di analisi)

Da questa esperienza stiamo anche cercando di costruire un libro (TBF)



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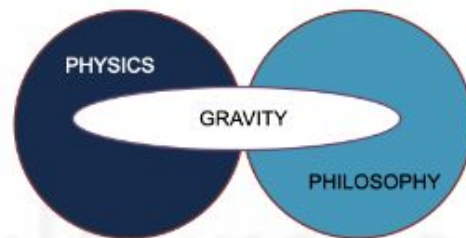
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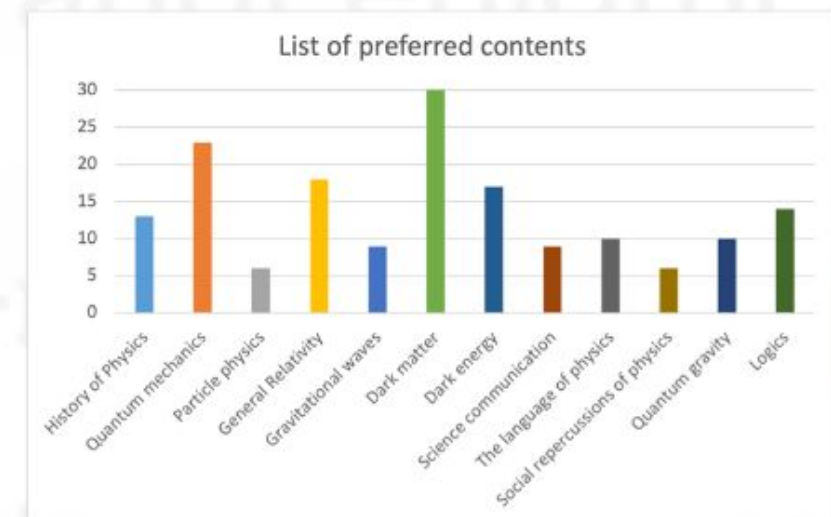


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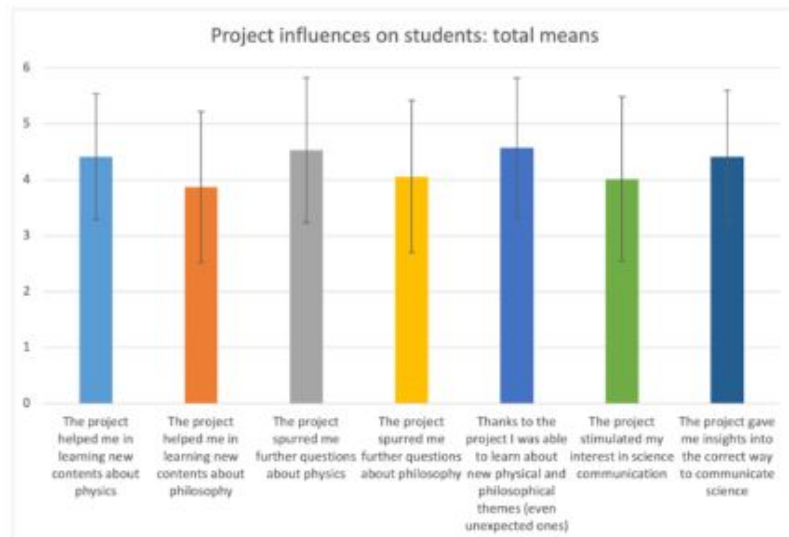


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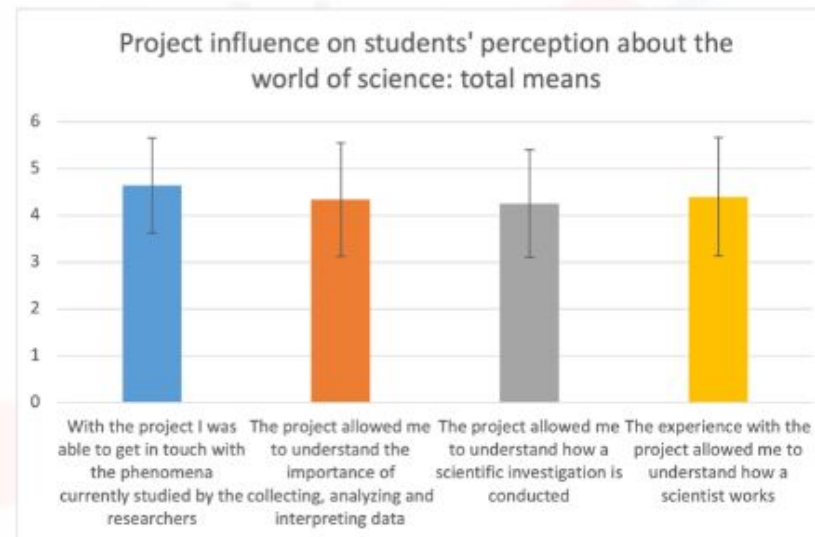


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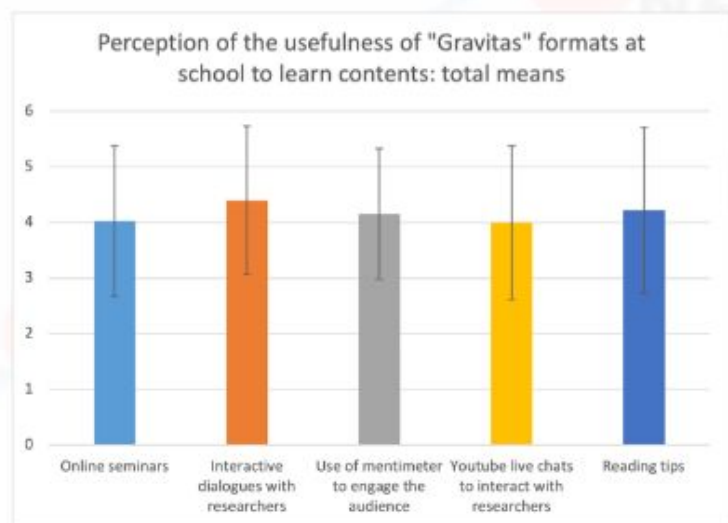


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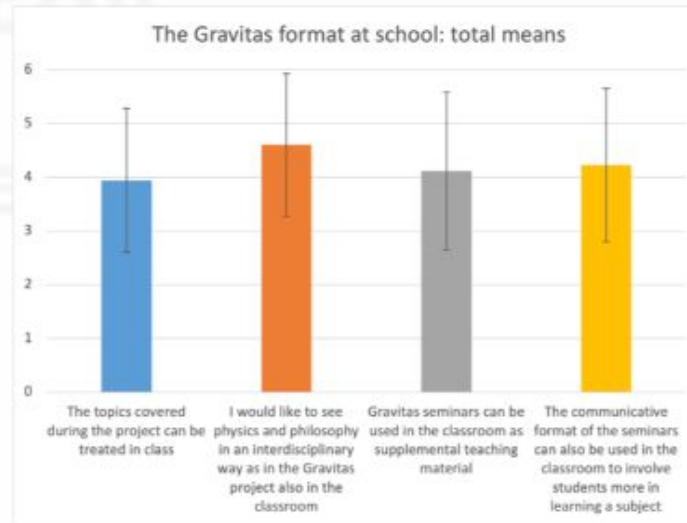


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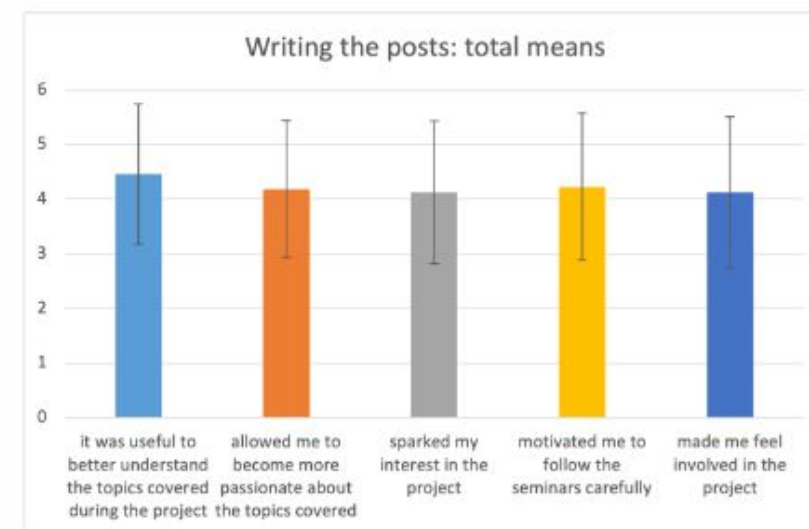


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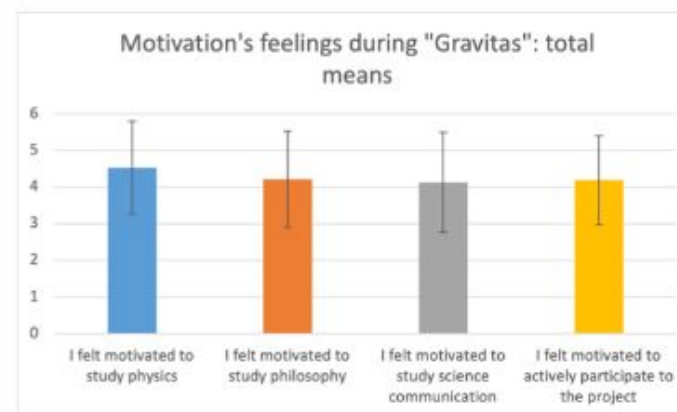


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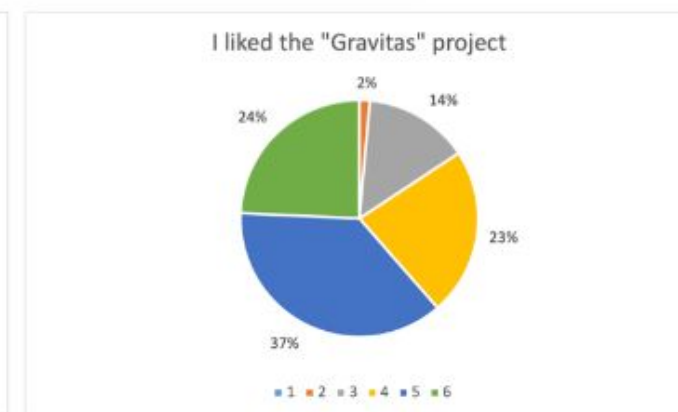


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## **Attivita' prossime DARK 2022**

Nuovi challenge:

Masterclass : in Dicembre → evento internazionale DarkSide

Dark Matter Day: organizzazione altro evento oltre alla collaborazione alla diretta LNGS (se la fa) dell'UC

Festival Gravitass in presenza a Cagliari



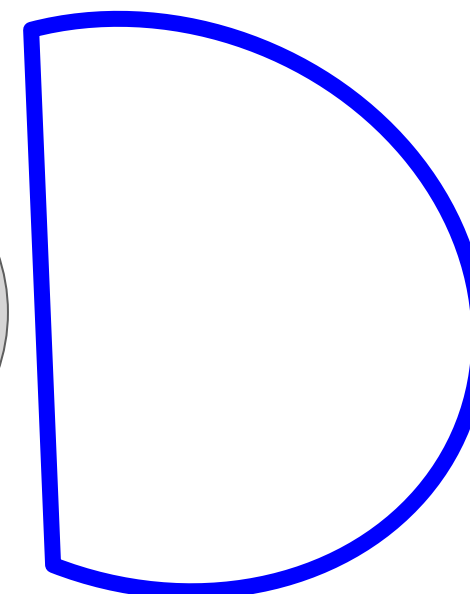
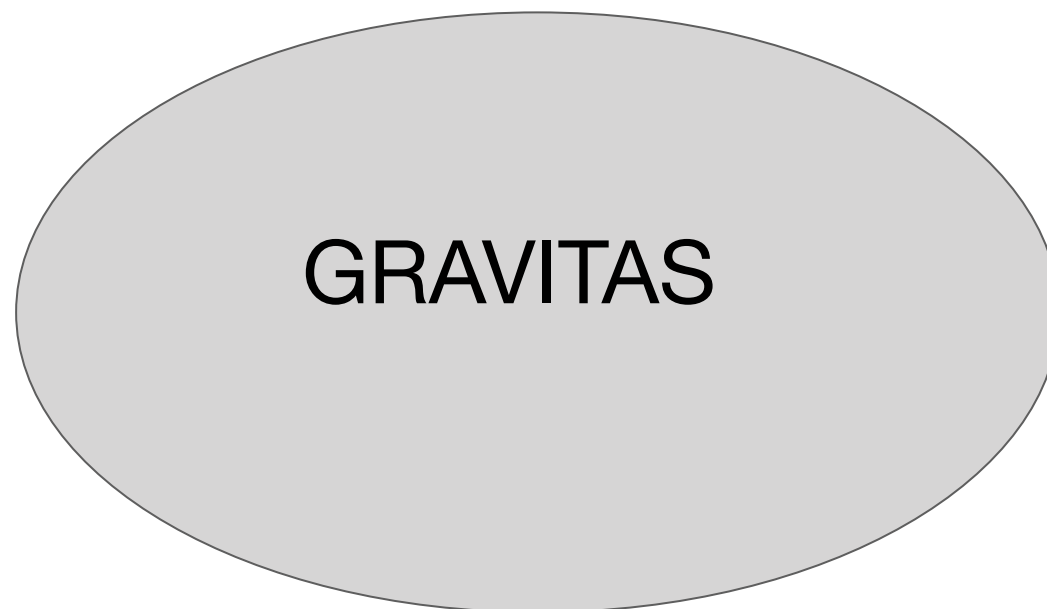
## **Festival in presenza : struttura**

Mattina Sabato: scuole

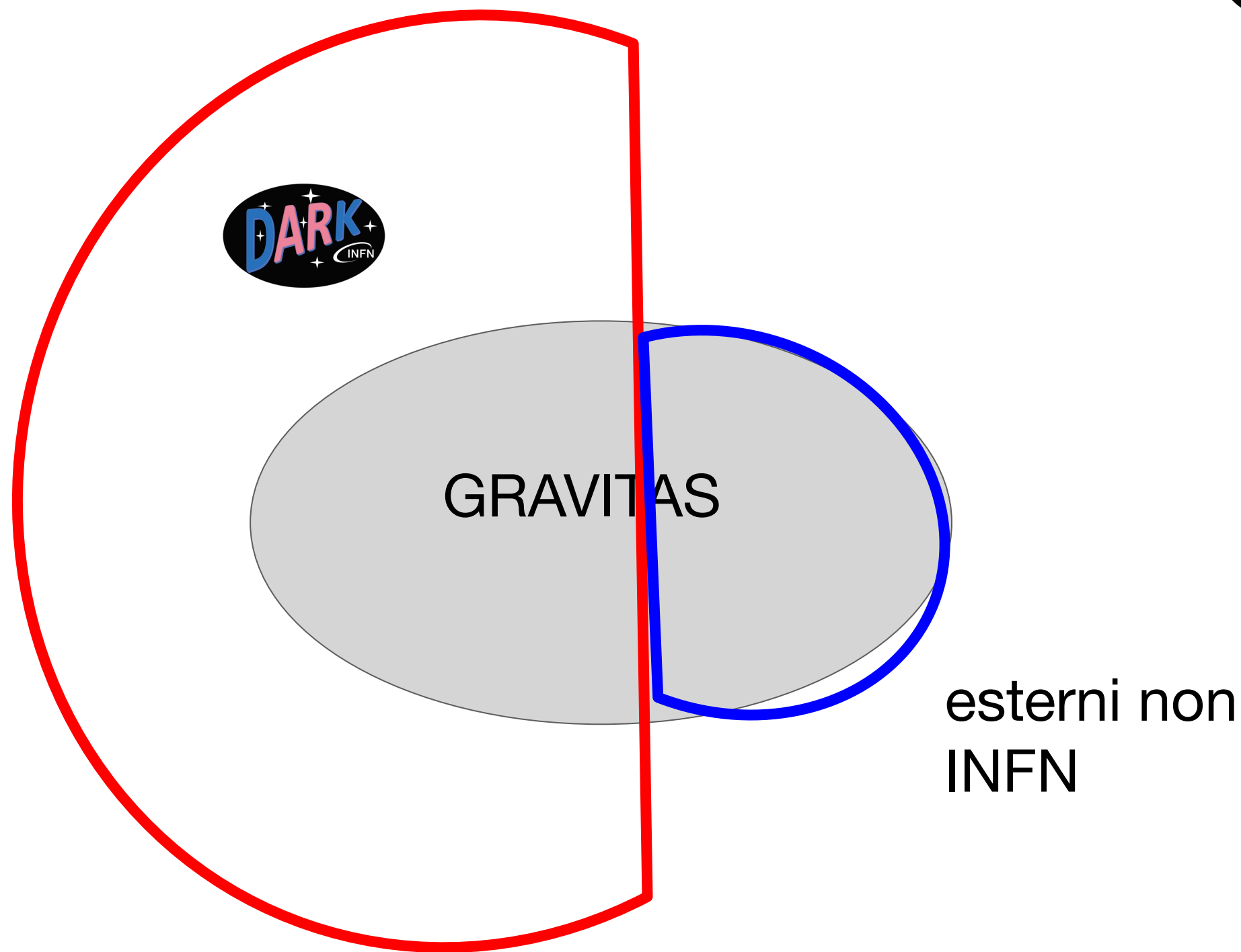
Pomeriggio Sabato e tutto Domenica: pubblico generico

Lectio magistralis  
dibattiti/tavole rotonde  
presentazioni libri  
momenti artistici  
spettacoli

L'evento, previa approvazione di UNICA, e' inserito come pre-evento della  
Notte dei Ricercatori - Sharper



esterni non  
INFN





## **Festival in presenza : i challenge**

E' la prima volta che organizziamo un "Festival"  
(scuole, conferenze, workshop, eventi divulgativi si ma non "Festival")

sala: prenotata (ordine in corso) 1keuro per 2 gg

ospiti "di fama" → non abbiamo i soldi per invitarli (un peccato, almeno qualche keuro sarebbe utile)

ospiti INFN → ok

ospiti non-INFN → vedremo le richieste che fanno (stiamo invitandoli)

In generale ci servirebbero un po di soldi anche per pagare qualche artista  
(non banale farsi finanziare da esterni essendo solitamente esclusi per definizione nei bandi gli enti pubblici)

## **Festival Gravitas, relazione con l' INFN**

Auspicabile la collaborazione con l'Ufficio Comunicazione INFN

Ci serve veramente una mano per l'aspetto informativo, contatti ecc.

In futuro, due possibili opzioni:

- 1) diventa evento INFN indipendente da DARK
- 2) rimane dentro DARK