

Novel cosmological and astrophysical tests of fundamental physics

Sunny Vagnozzi

for the FLAG iniziativa specifica

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Riunione preventivi TIFPA 2023, 4 July 2023



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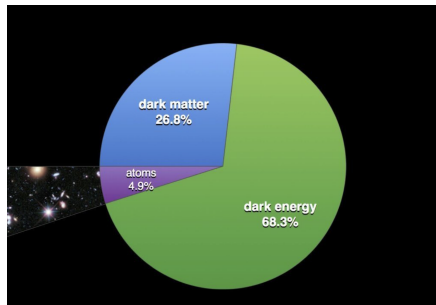
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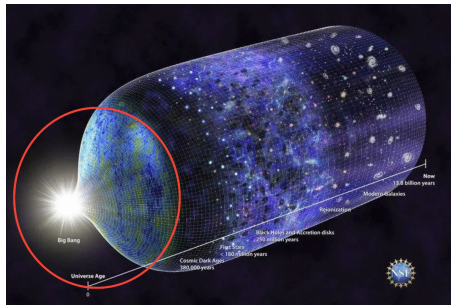
What we (don't) know about our Universe

The Λ CDM model: dark matter and dark energy



Credits: NSF

Inflation (the real “Big Bang”): trick or treat?

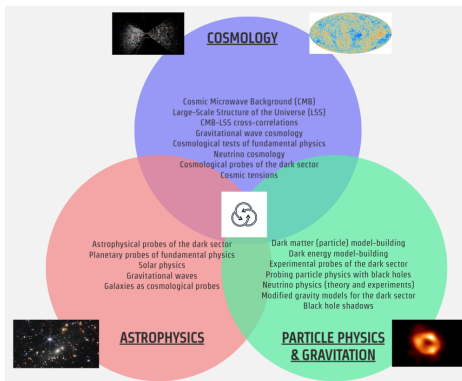


Credits: Katie Mack

Most of our Universe is still unknown!

Big data and big open questions

Deluge of data to tackle big questions and illuminate the dark universe...

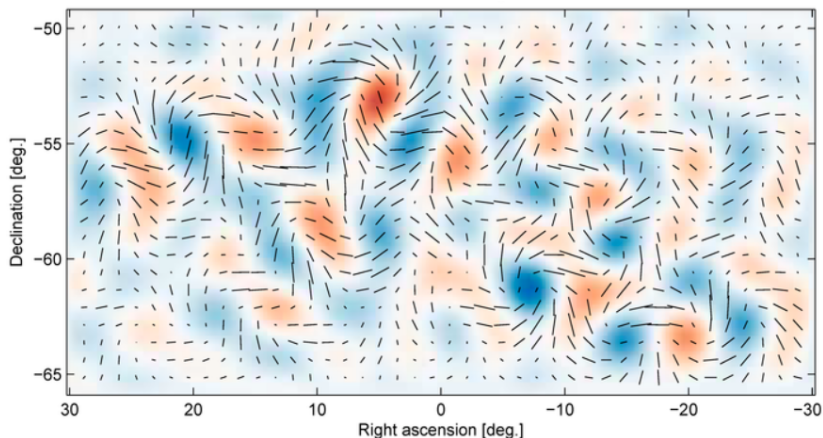


...yet “standard” approaches have mostly returned empty-handed!

Can we look beyond the lamppost/off the beaten track?

B-modes from inflation

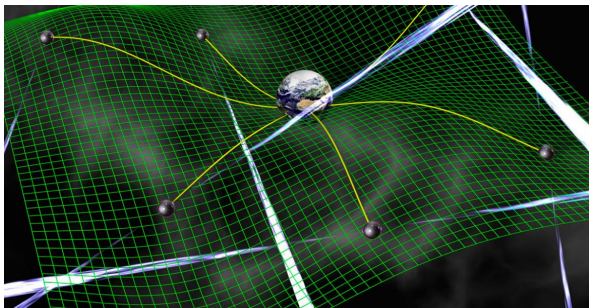
Primordial gravitational waves imprinted in the CMB polarization



Credits: BICEP-2 collaboration

Can we look for inflation elsewhere?

Pulsar timing arrays



Credits: David Champion

June 29, 2023: **first ever stochastic GW background detection!**
(NANOGrav, EPTA, PPTA, CPTA)

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Redazioni Tgr Rai News 24 • LIVE

SCIENZA E TECNOLOGIA

L'universo ci parla: catturato per la prima volta il ronzio delle onde gravitazionali

Un importante risultato scientifico ottenuto grazie agli sforzi congiunti di centinaia di scienziati che hanno impiegato radiotelescopi in diverse parti del mondo

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Did pulsar timing arrays observe footprints of inflation?

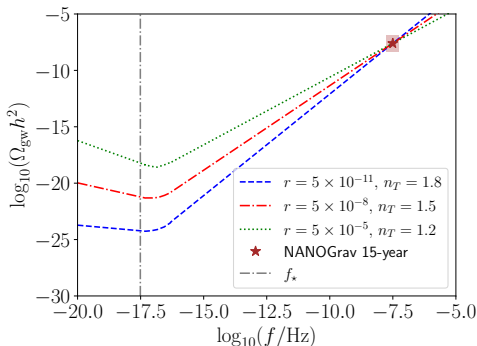
Inflationary interpretation of the stochastic gravitational wave background signal detected by pulsar timing array experiments

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(Dated: June 30, 2023)



SV, arXiv:2306.16912

Maybe, but it would be a very non-standard model for inflation (“blue” spectrum, low reheating scale)!

⇒ food for particle physicists and for LISA?

Did inflation really occur?

THE ASTROPHYSICAL JOURNAL LETTERS, 939:L22 (5pp), 2022 November 10

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<https://doi.org/10.3847/2041-8213/ac944c>



The Challenge of Ruling Out Inflation via the Primordial Graviton Background

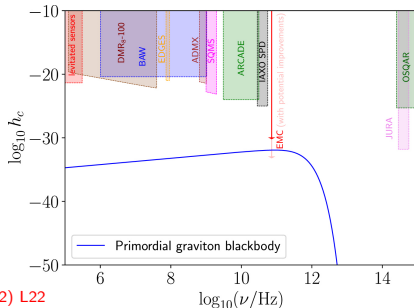
Sunny Vagnozzi^{1,2} and Abraham Loeb³

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SV & Loeb, ApJ Letters 939 (2022) L22

il Dolomiti

RICERCA E UNIVERSITÀ

"Fondo di gravitoni": lo studio di Vagnozzi (UniTn) e del collega Loeb apre una nuova porta per falsificare il paradigma più accreditato sulla formazione dell'Universo

Lo studio dei ricercatori Sunny Vagnozzi (Università di Trento) e Avi Loeb (Università di Harvard) ha snobbato "le teorie più accreditate della nascita dell'Universo osservabile e falsificabile".



TELESCOPIO UNIVERSITARIO

Dubbi sulla nascita del cosmo: nel team anche un ricercatore dell'università di Trento



LA RISPOSTA NEL FONDO COSMICO DI GRAVITONE
Si può escludere l'inflazione cosmica?

Secondo alcuni, nell'astrofisica, tra cui l'italiano Sunny Vagnozzi, l'inflazione cosmica in linea di principio potrebbe essere scartata se si riuscisse a rilevare il fondo cosmico di gravitoni. Lo studio di Avi Loeb non consente infatti l'esclusione di tale fondo, poiché suggerisce che l'impressione osservata dell'Universo osservato lo abbia rifiutato al punto da non essere rilevabile. Tutti i dettagli su ApJ Letters

Using asteroids to search for dark matter

Journal of Cosmology and Astroparticle Physics

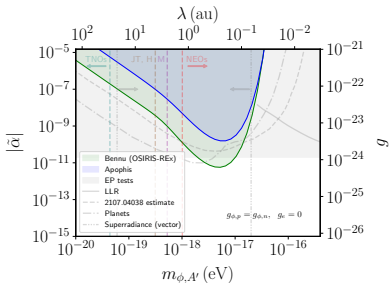
PAPER

Novel constraints on fifth forces and ultralight dark sector with asteroidal data

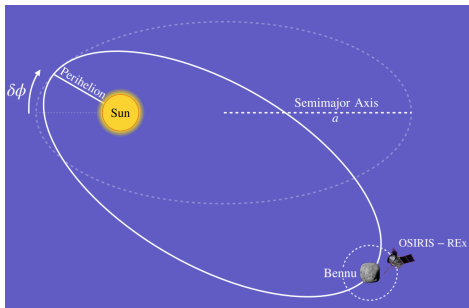
Yu-Dai Tsai^{1,2,3}, Youjia Wu⁴, Sunny Vagnozzi^{1,5,7} and Luca Visinelli^{8,9}

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Journal of Cosmology and Astroparticle Physics, Volume 2023, April 2023



Tsai, Wu, SV, Visinelli, JCAP 2304 (2023) 031



MOTHERBOARD
SERVICES

Scientists Want to Use Asteroids to Search for Hidden 'Fifth Force'

Tiny changes in the motions of space rocks could reveal a hidden force that might help explain major mysteries, such as dark matter and dark energy.

Using asteroids to search for dark matter

Fall 2023 will be “asteroid autumn”: return of a sample from Bennu, most precisely tracked asteroid (radar astrometry to $\lesssim 2$ m precision!)

Leading constraints on fifth forces and ultralight dark matter from the OSIRIS-REx mission and ultraprecise asteroid astrometry

Yu-Dai Tsai^{1,2,3,*} Davide Farnocchia^{4,†} Marco Micheli^{5,‡} Sunny Vagnozzi^{6,7,§} and Luca Visinelli^{8,9,¶}

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Tsai, Farnocchia, Micheli, SV, Visinelli, in preparation



Credits: NASA

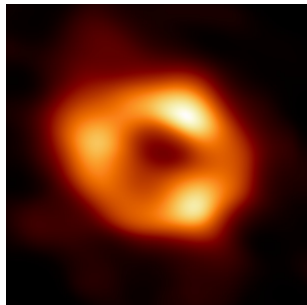
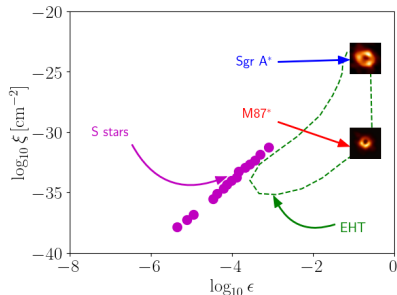
Testing fundamental physics with black hole shadows

Classical and Quantum Gravity

ACCEPTED MANUSCRIPT • OPEN ACCESS

Horizon-scale tests of gravity theories and fundamental physics from the Event Horizon Telescope image of Sagittarius A*

Sunny Vagnozzi¹, Rittick Roy², Yu-Dai Tsai³, Luca Visinelli⁴, Misba Afrin⁵, Alireza Allahyari⁶, Parth Bambhaniya⁷, Dipanjan Dey⁸, Sushant G Ghosh⁹, Pankaj S. Joshi¹⁰, Kimet Jusufi¹¹, Mohsen Khodadi¹², Rahul Kumar Walia¹³, Ali Övgün¹⁴ and Cosimo Bambi¹⁵ → Hide full author list
Accepted Manuscript online 26 May 2023 • © 2023 The Author(s). Published by IOP Publishing Ltd



SV *et al.*, to appear in CQG [arXiv:2205.07787]

Credits: EHT collaboration

Big data and big open questions

With the deluge of diverse, ultraprecise data reaching us in the upcoming decade, it is imperative to look beyond the lamppost/off the beaten track to answer the big open questions about our Universe!

