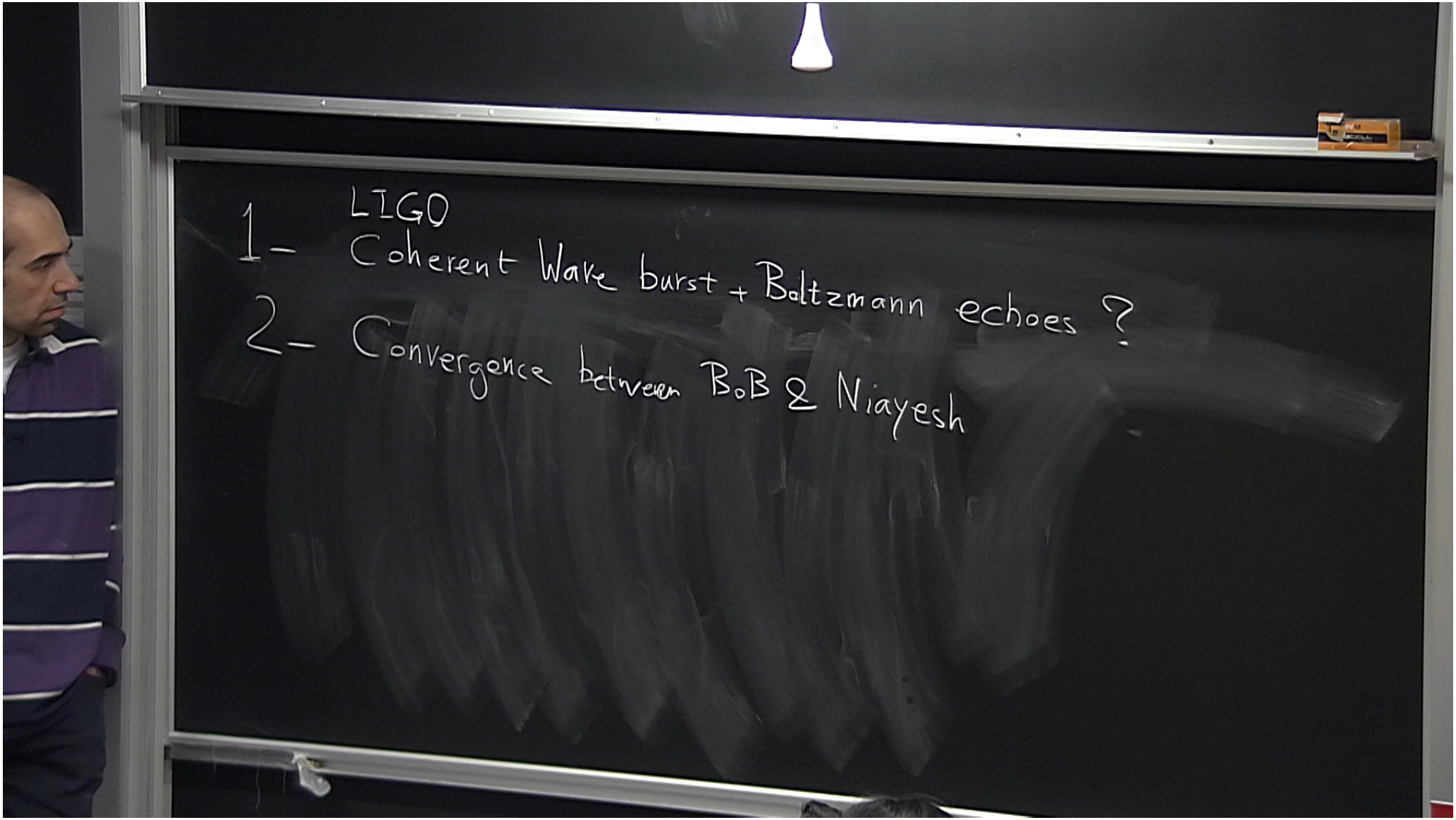
Title: Discussion and Outlook

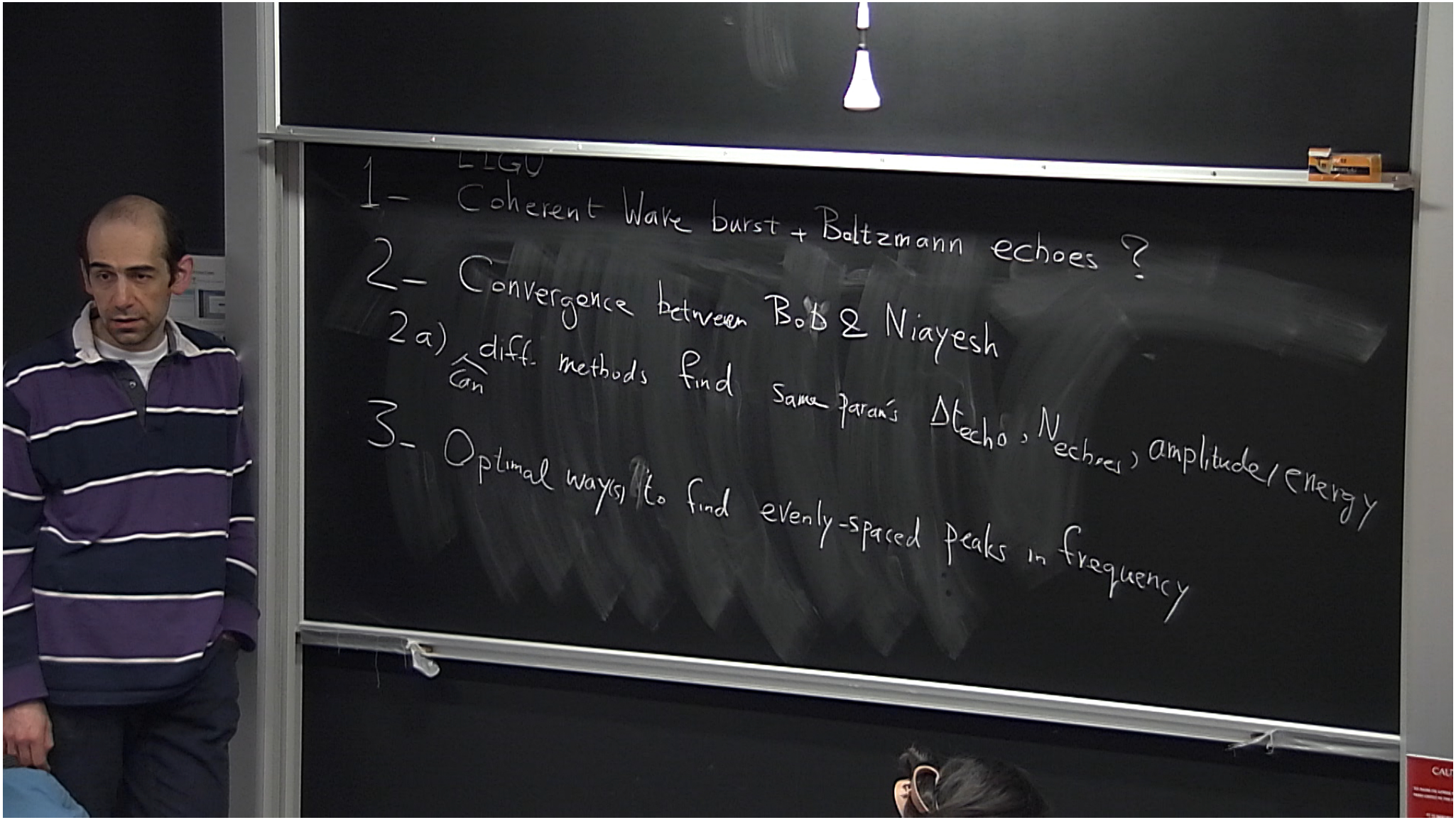
Speakers: Niayesh Afshordi

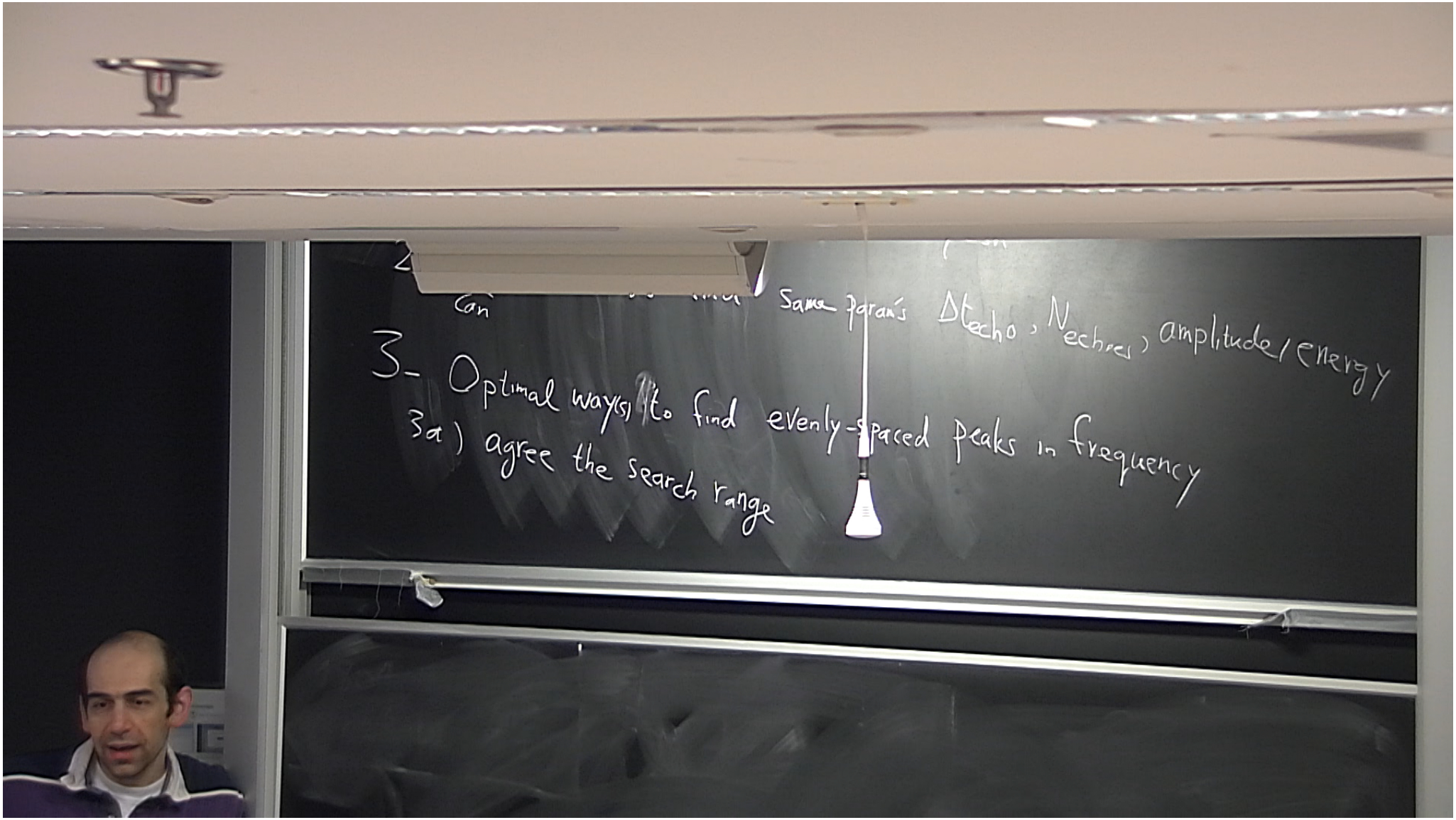
Collection: Echoes in Southern Ontario

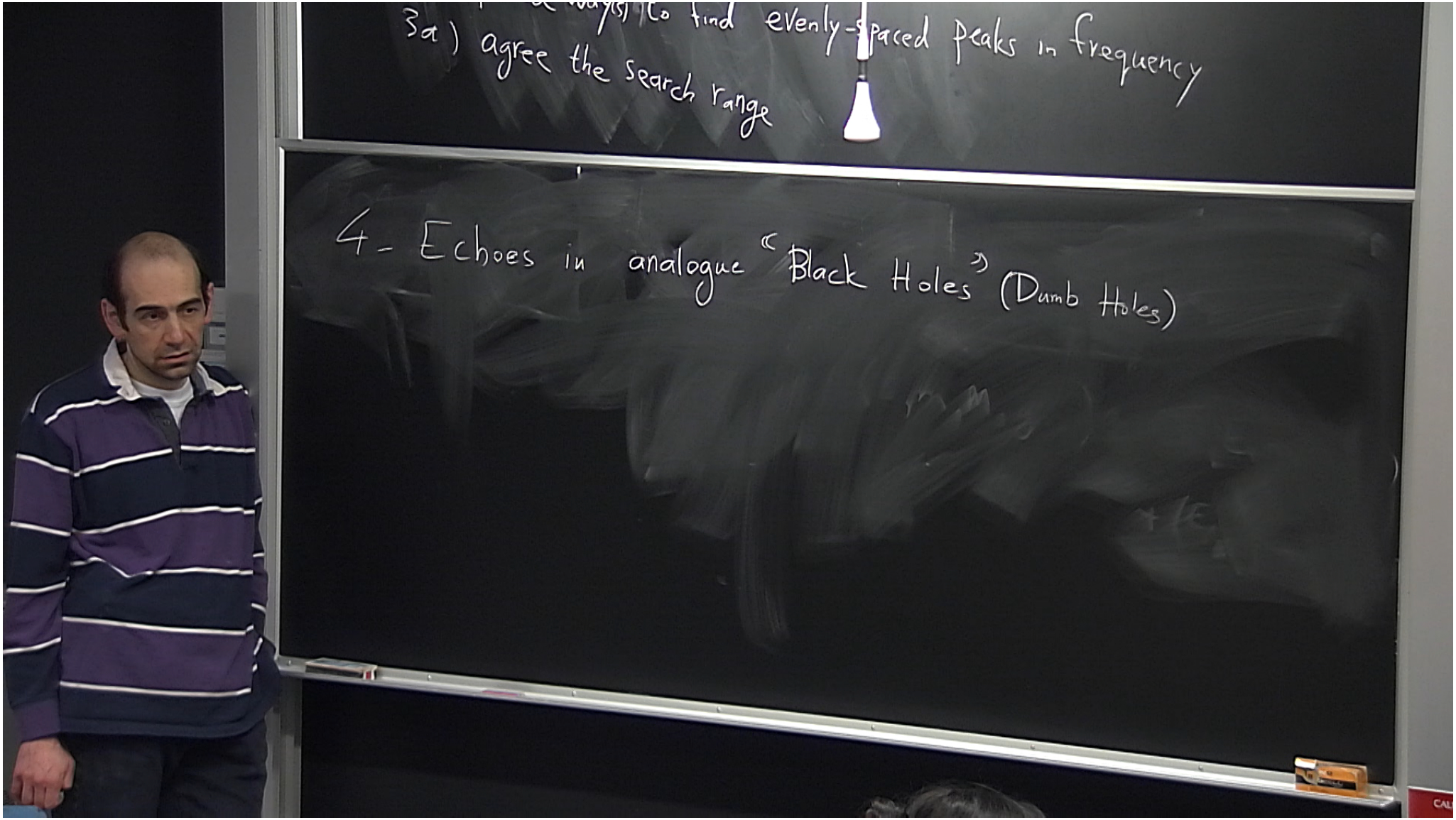
Date: February 25, 2020 - 3:00 PM

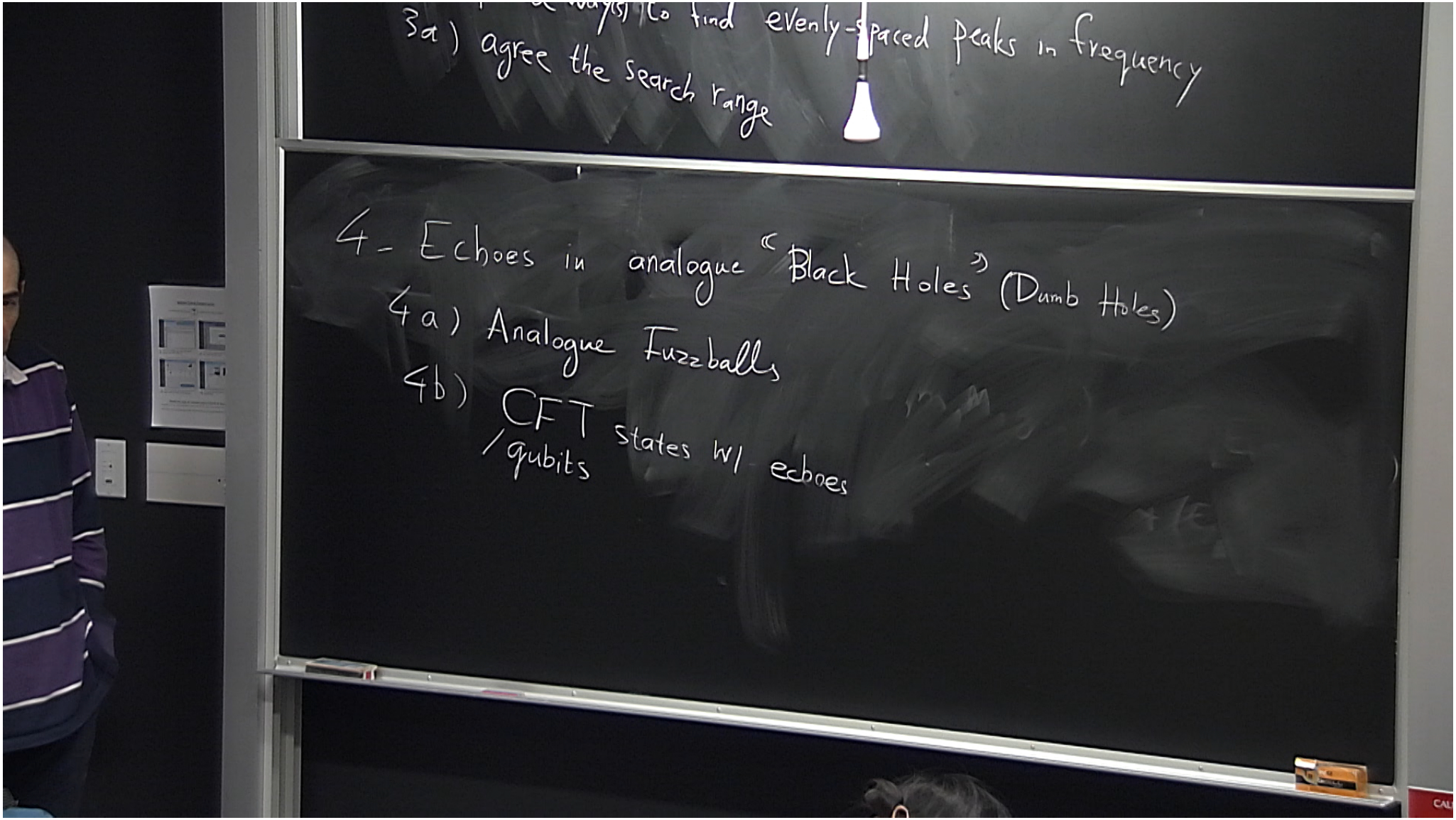
URL: http://pirsa.org/20020096

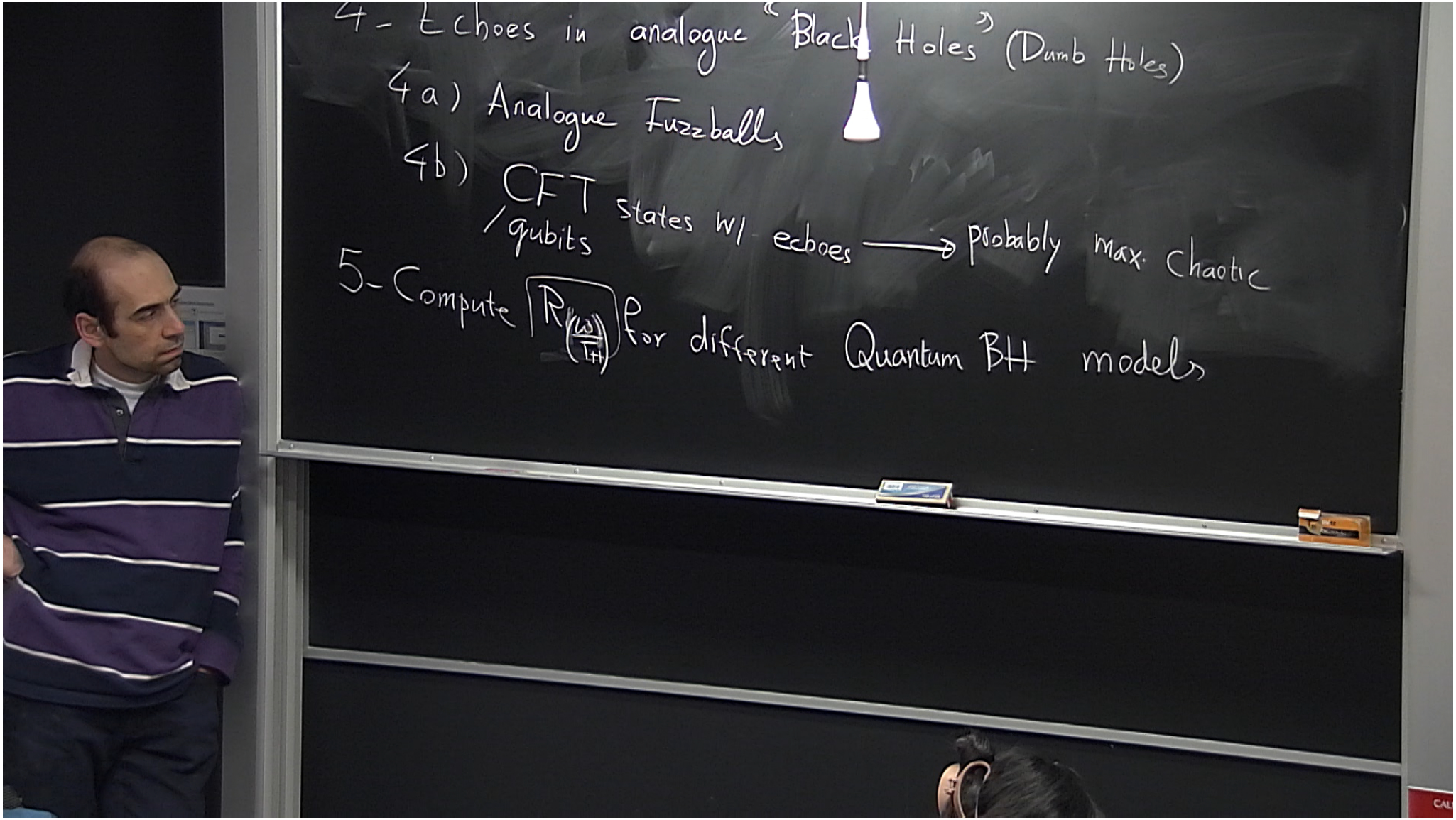

1- LIGO
Coherent Wave burst + Boltzmann echoes ?
2- Convergence between B.B & Niayesh

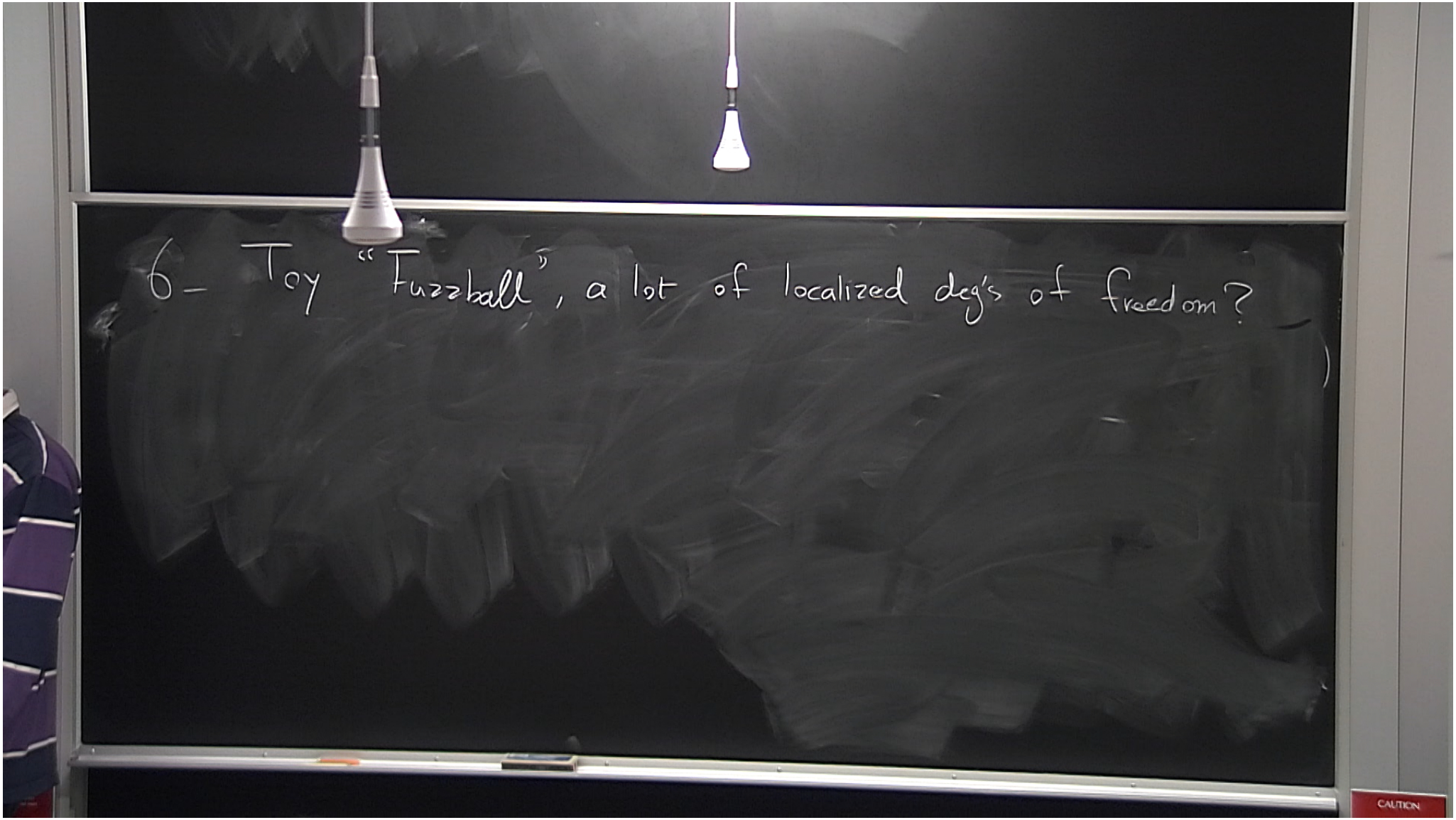

LIGO
1- Coherent Wave burst + Boltzmann echoes ?
2- Convergence between Bob & Niayesh
2a) diff. methods find same params Δtecho, Nechoes, amplitude/energy
can
3- Optimal ways to find evenly-spaced peaks in frequency

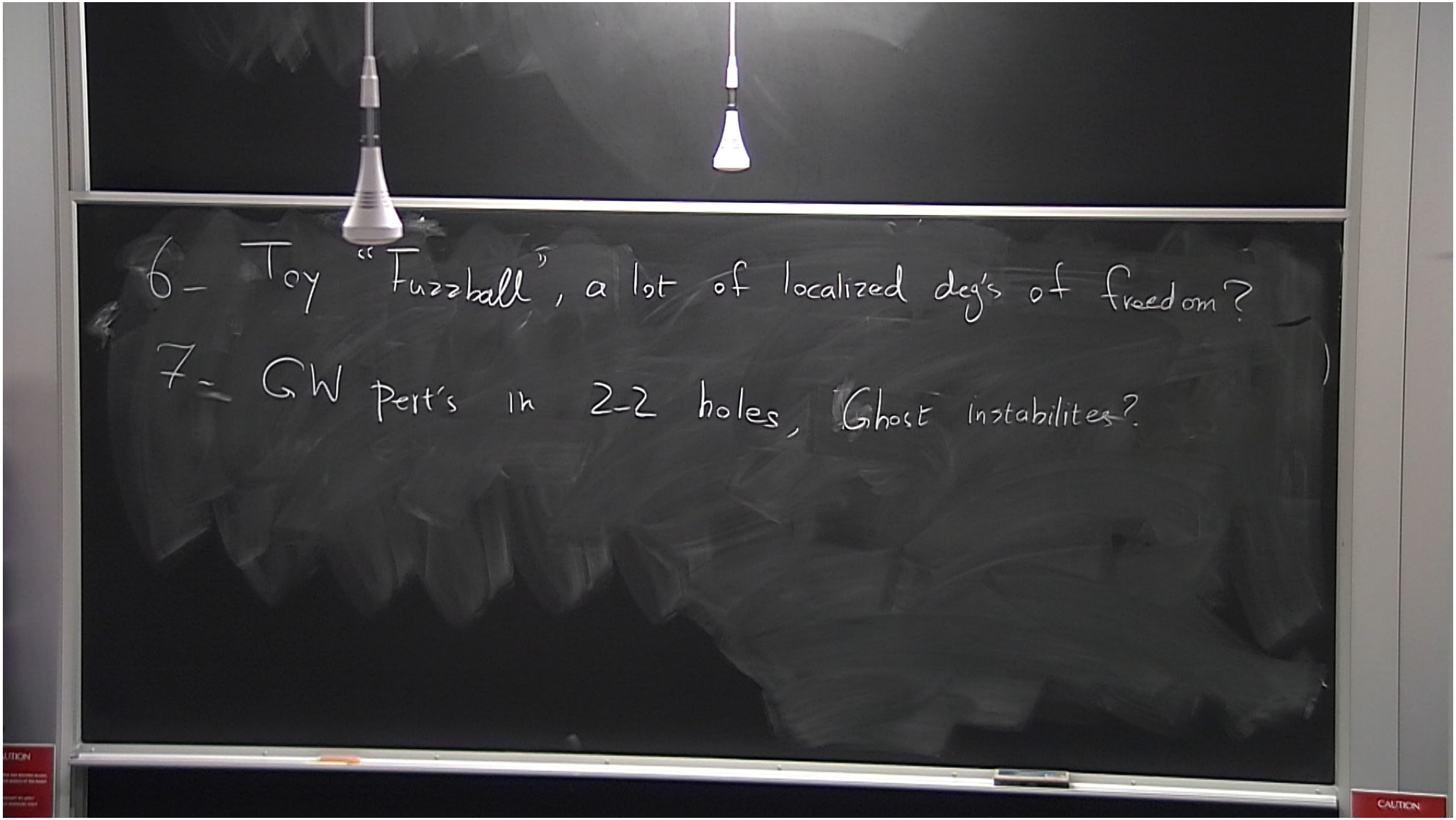

Same params Δtecho, Nechoes, amplitude/energy
3- Optimal way(s) to find evenly-spaced peaks in frequency
3a) agree the search range


3a) agree the search range
find evenly-spaced peaks in frequency
4- Echoes in analogue « Black Holes » (Dumb Holes)


3a) agree the search range
4- Echoes in analogue "Black Holes" (Dumb Holes)
4a) Analogue Fuzzballs
4b) CFT states w/ echoes
/qubits


4- Echoes in analogue "Black Holes" (Dumb Holes)
4a) Analogue Fuzzballs
4b) CFT states w/ echoes → probably max. Chaotic
/qubits
5- Compute R(ω/T_H) for different Quantum BH models


6- Toy "Fuzzball", a lot of localized deg's of freedom?
CAUTION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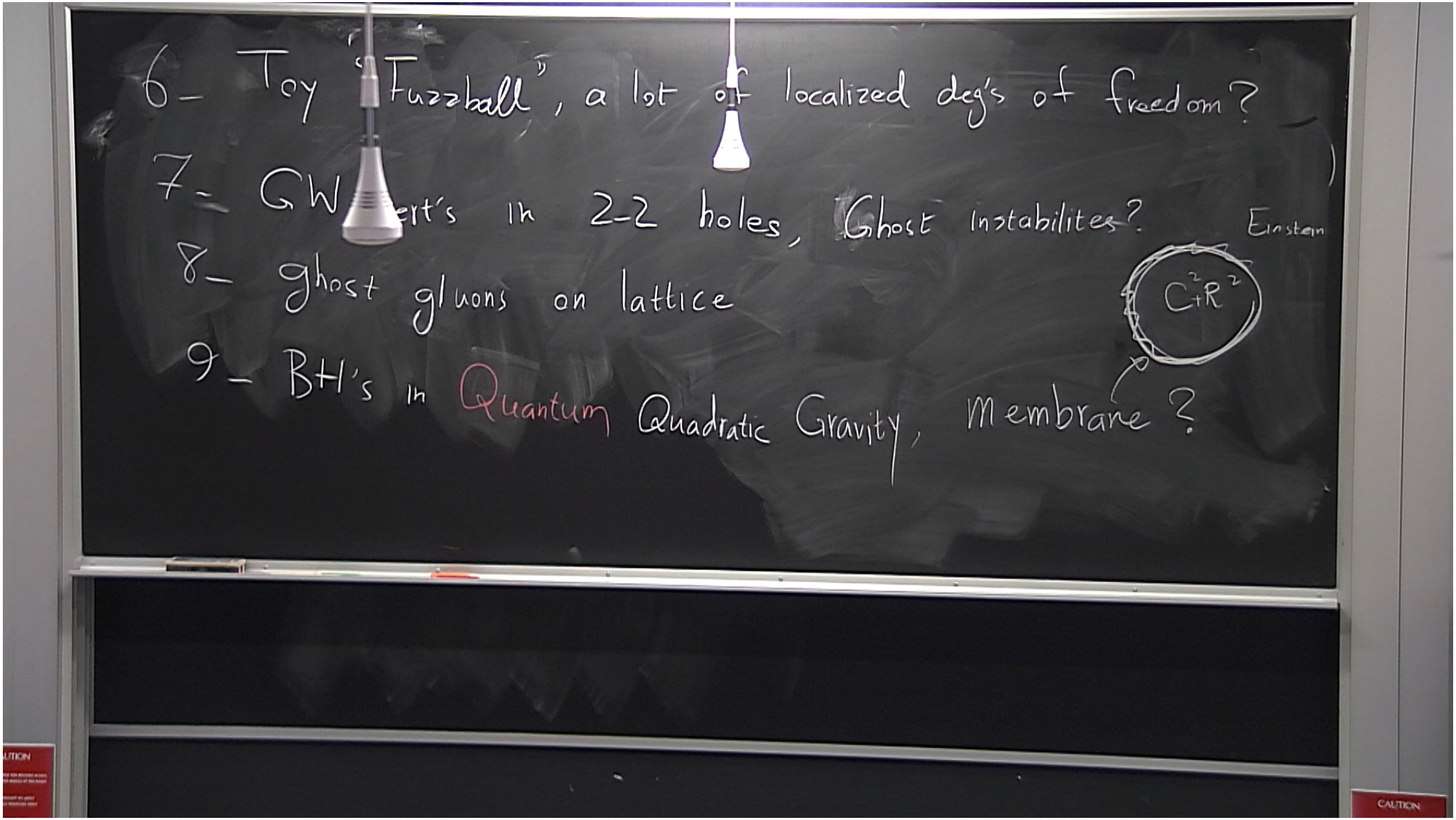
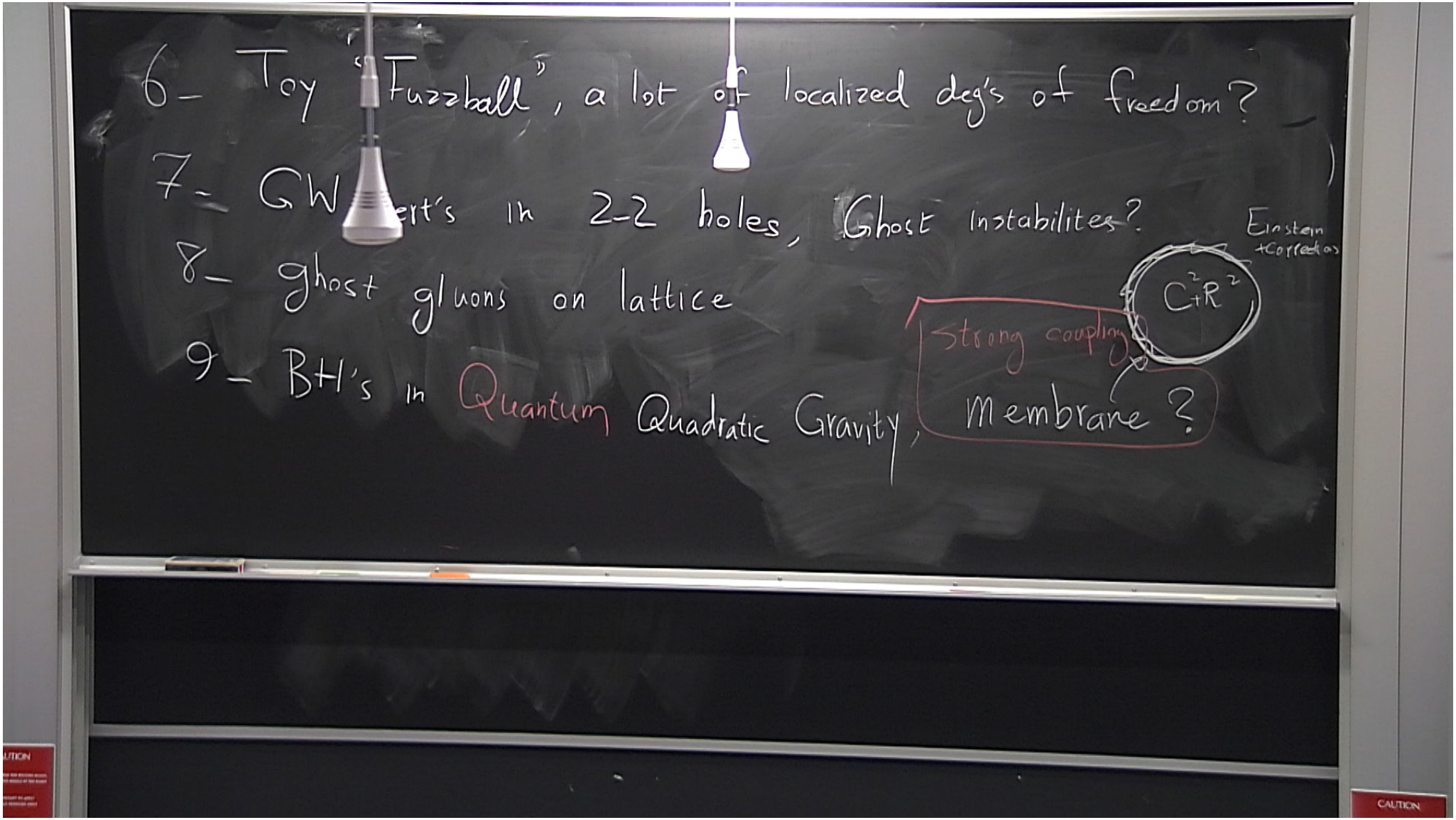
7- GW Pert's in 2-2 holes, Ghost instabilites?


6_ Toy "Fuzzball", a lot of localized deg's of freedom?
7_ GW ert's in 2-2 holes, Ghost Instabilites?
8_ ghost gluons on lattice
9_ BH's in Quantum Quadratic Gravity, Membrane?
Einstein
C²+R²


6- Toy "Fuzzball", a lot of localized deg's of freedom?
7- GW ert's in 2-2 holes, Ghost Instabilites?
8- ghost gluons on lattice
9- BH's in Quantum Quadratic Gravity,
Strong coupling
Membrane?
Einstein +Corrections
C^2+R^2
CAUTION

LETTER

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Nine-hour X-ray quasi-periodic eruptions from a low-mass black hole galactic nucleus

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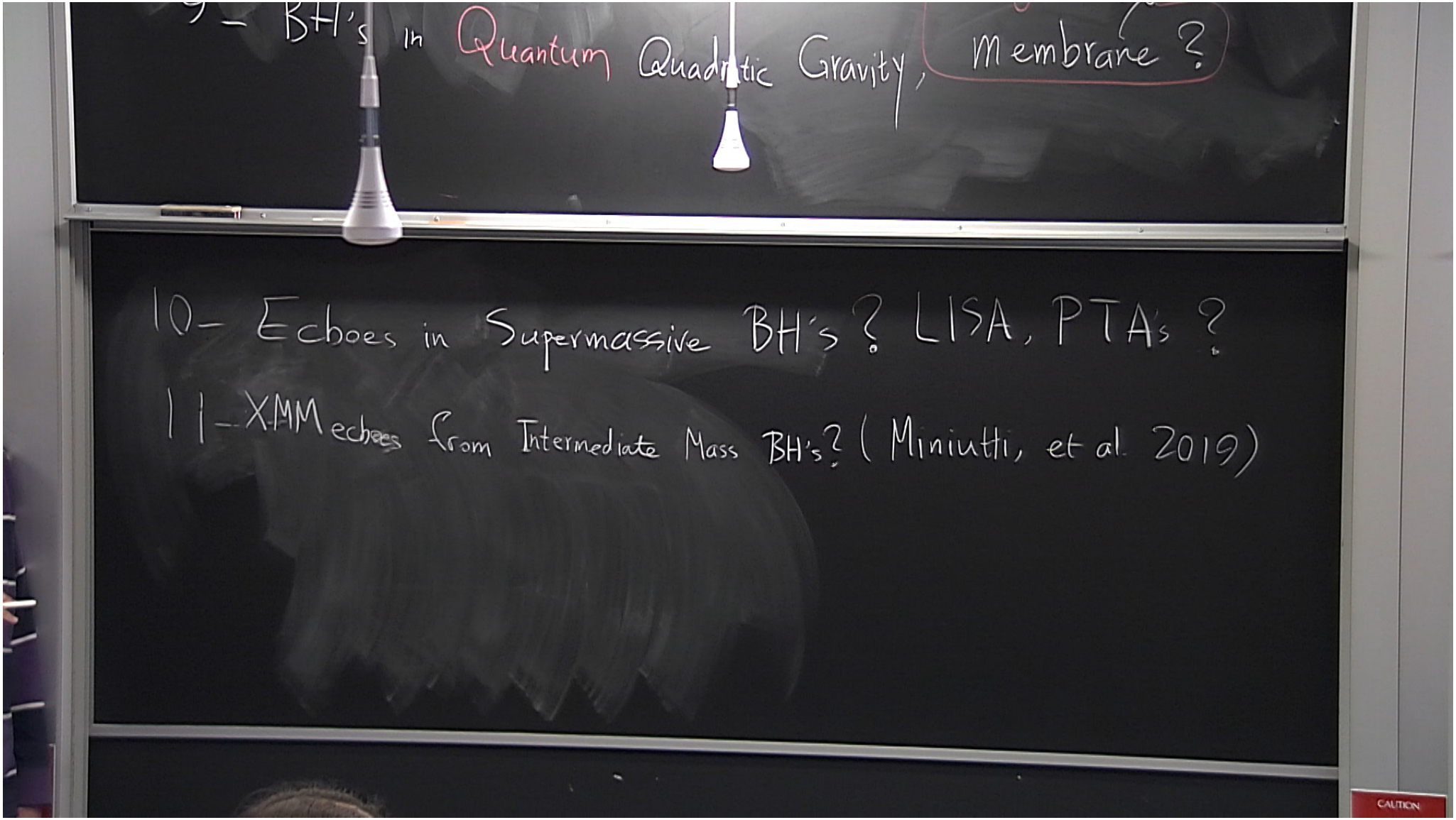
In the past two decades, high-amplitude electromagnetic outbursts have been detected from dormant galaxies and often attributed to the tidal disruption of a star by the central black hole[1,2]. X-ray emission from the Seyfert 2 galaxy GSN 069 (2MASX J01190869-3411305) at a redshift of $z = 0.018$ was first detected in July 2010 and implies an X-ray brightening by a factor of more than 240 over ROSAT observations performed 16 years earlier[3,4]. The emission has smoothly decayed over time since 2010, possibly indicating a long-lived tidal disruption event[5]. The X-ray spectrum is ultra-soft and can be described by accretion disk emission with luminosity proportional to the fourth power of the disk temperature during long-term evolution. Here we report observations of quasi-periodic X-ray eruptions from the nucleus of GSN 069 over the course of 54 days, from December 2018 onwards. During these eruptions, the X-ray count rate increases by up to two orders of magnitude with an event duration of just over an hour and a recurrence time of about nine hours. These eruptions are associated with fast spectral transitions between a cold and a warm phase in the accretion flow around a low-mass black hole (of approximately 4×10^5 solar masses) with peak X-ray luminosity of about 5×10^{42} erg per second. The warm phase has kT (where T is the temperature and k is the Boltzmann co[illegible] typical soft-X[illegible] in the X-ray s[illegible]

observed in a potentially long enough XMM-Newton exposure (83 ks) on 2014 December 5 (XMM2)—that is, four years before the XMM3 discovery observation.

The observed X-ray variability is characterized by short, high-amplitude quasi-periodic X-ray bursts over a rather stable flux level (Fig. 1). This type of variability has not hitherto been observed in an active galactic nucleus (AGN). Hereafter, we refer to these new phenomena as X-ray quasi-periodic eruptions (QPEs) to differentiate them from the gentler, quasi-sinusoidal modulation of the standard quasi-periodic oscillations (QPOs) that are often observed in X-ray binaries[10] and, more recently, in a handful of supermassive accreting black holes[11,12].

Over the 54 days probed by our recent observations, the QPE amplitude decreases with time, and a simple linear extrapolation predicts no QPEs from about late June 2019 onwards, if the current trend continues. The average QPE duty cycle is about 6%, and it is well correlated with the average amplitude, whereas the QPE recurrence time seems to tend to a plateau at about 33 ks after an initial increase (see Methods section 'QPE model-independent properties' and Extended Data Fig. 4). Radio DDT observations with the MeerKAT, Karl G. Jansky Very Large Array (VLA) and Australia Telescope Compact Array (ATCA) radio telescope [illegible] ar [illegible] handra observa- [illegible] GHz, 6 GHz and [illegible] $erg\,s^{-1}$ and a spec-


9- BH's in Quantum Quadratic Gravity, Membrane ?
10- Echoes in Supermassive BH's? LISA, PTA's ?
11- XMM echoes from Intermediate Mass BH's? (Miniutti, et al. 2019)
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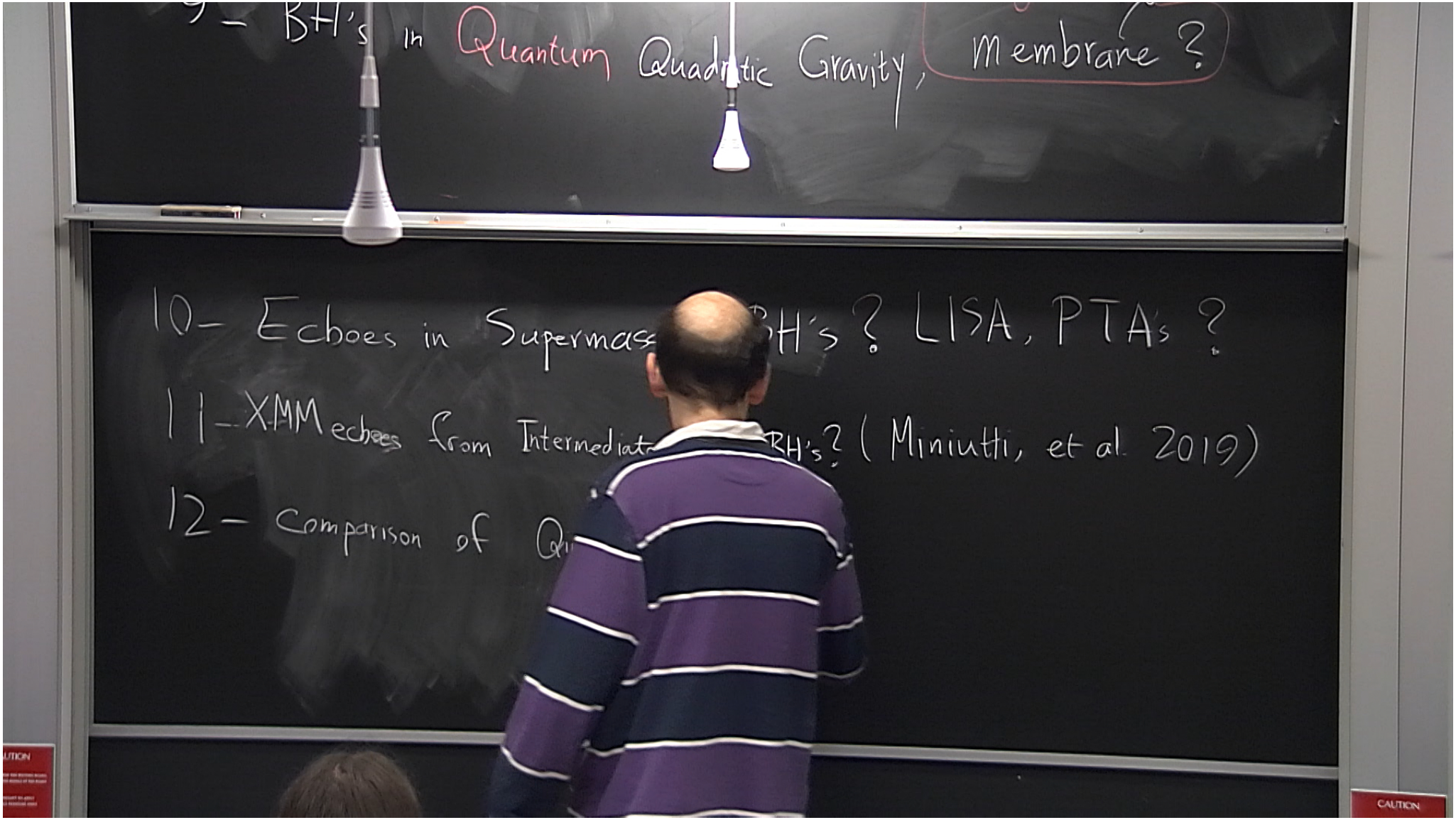
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12- Comparison of Q
CAUTION