Gong Show

Session Chair

Masahito Yamazaki

1. Marco Bertolini
2. Dmitry Chernyak
3. Peter Cox
4. Will Donovan
5. Hajime Fukuda
6. Akishi Ikeda
7. Miho Ishigaki
8. Chen Jiang
9. Shunsuke Maeda
10. Tom Melia
11. Surhud More
12. Ryoma Murata
13. Genki Ouchi
14. Charles Henry Simpson
15. Alessandro Sonnenfeld
16. Michihisa Takeuchi
17. Tomislav Vladisavljevic
18. Benda Xu
19. Kazuya Yonekura

" B/2 correlators in (0,2) hybrid models "

Marco Bertolini

Towards (0,2) mirror symmetry

Goal

Understand the moduli space of 2D SCFTs with (0,2) SUSY.

(2,2) mirror symmetry

- Geometry:

$$\begin{aligned} M \quad \mathrm{CY}_3 \quad &\longleftrightarrow \quad \widehat{M} \quad \mathrm{CY}_3 \\ \text{Kähler (A model)} \quad &\longleftrightarrow \quad \text{complex str. (B model)} \\ \text{complex str. (B model)} \quad &\longleftrightarrow \quad \text{Kähler (A model)} \end{aligned}$$

- In general:

$$(2,2)\ \mathrm{SCFT} \quad \longleftrightarrow \quad (2,2)\ \widehat{\mathrm{SCFT}}$$

Towards (0,2) mirror symmetry

(0,2) mirror symmetry

- Geometry:

$$\begin{aligned} (M,\mathcal{E})\ \ \text{CY}_3 + \text{bundle} \quad &\overset{?}{\longleftrightarrow} \quad (\widehat{M},\widehat{\mathcal{E}})\ \ \text{CY}_3 + \text{bundle} \\ (\text{A}/2\text{ model}) \quad &\overset{?}{\longleftrightarrow} \quad (\text{B}/2\text{ model}) \\ (\text{B}/2\text{ model}) \quad &\overset{?}{\longleftrightarrow} \quad (\text{A}/2\text{ model}) \end{aligned}$$

- (0,2) as a deformation of (2,2):
  - We are guaranteed success!
  - Some proposals [Melnikov&Plesser '11, Sharpe&Gu'17].
  - Complete map is still missing.

Strategy

To deepen the understanding of the twisted theories (A/2 and B/2 models) for a larger class of models.

B/2 correlators in (0,2) hybrid models

(0,2) hybrid models [MB&Plesser]

- LG fibered over a compact NLSM.
- Local model: $\mathcal{E} \to \boldsymbol{Y} = \mathrm{tot}\,(X \to B) +$ superpotential $J \in \Gamma(\mathcal{E}^\vee)$.

B/2 correlators [MB&Romo]

- S^2 localization

$$\langle \mathcal{O}_1 \mathcal{O}_2 \mathcal{O}_3 \rangle_{S^2} = \int_{\boldsymbol{Y}} \Omega_{\mathcal{E}} \lrcorner \left(e^{\widehat{L}} \mathcal{O}_1 \mathcal{O}_2 \mathcal{O}_3 \right)$$

- It determines the relations in the heterotic topological ring.
- In a subclass of theories instanton corrections are absent
  $\longrightarrow$ (0,2) mirror candidates!

Search for physics beyond Standard Model using ultra-radio-pure NaI(Tl) crystals

Dmitry CHERNYAK

Kavli Institute for the Physics and Mathematics of the Universe, The University of Tokyo, Kashiwa, Japan

Development of ultra-radio-pure NaI(Tl) crystals

We **successfully developed ultra-radio-pure NaI(Tl) scintillators**. **The new Ø5×5 inch crystal was produced** recently and will be tested in our clean room laboratory at the Kamioka mine.

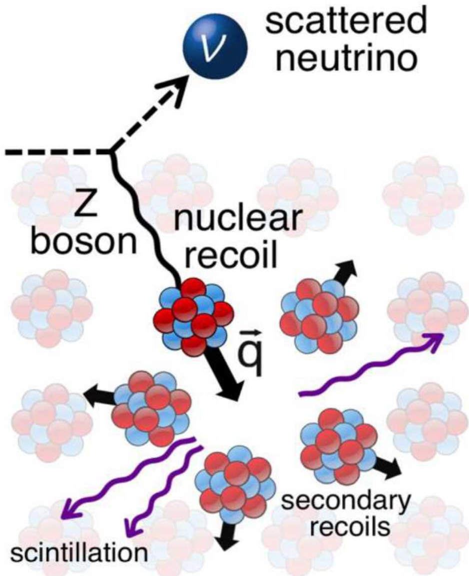
Our Kavli IPMU team:

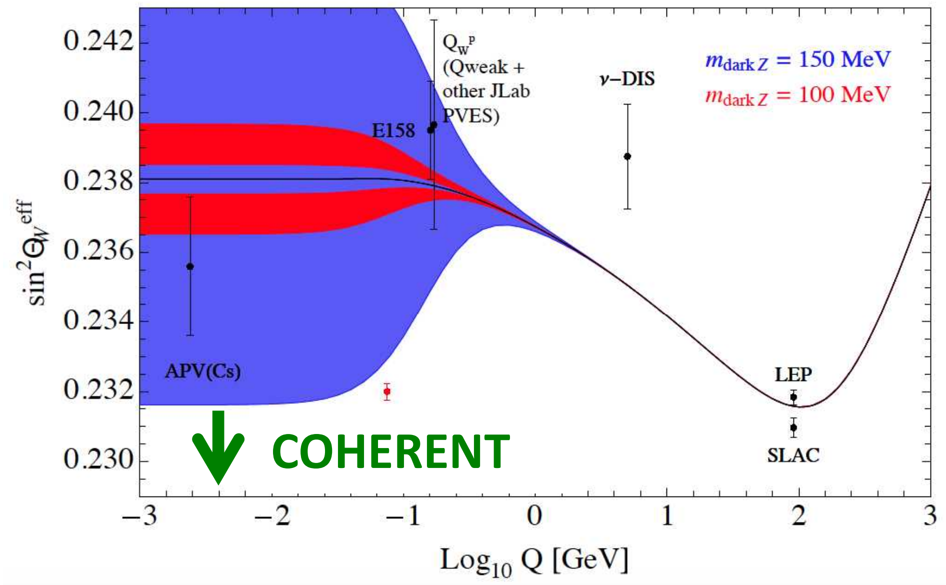
Alexandre Kozlov – group leader
Yasuhiro Takemoto – DAQ expert
Dmitry Chernyak – detector construction

Impurity	DAMA/LIBRA	DM-ICE	ANAIS	KIMS	Our results
^{nat}K [ppb]	< 20	558	20 ~ 46	40 ~ 50	125
Th-chain [ppt]	0.5 ~ 7.5	13	0.8 ± 0.3	0.5 ± 0.3	0.3 ± 0.5
^{226}Ra [µBq/kg]	21.7 ± 1.1	900	10 ± 0.2	< 1	58 ± 4
^{210}Pb [µBq/kg]	24.2 ± 1.6	1500	600 ~ 800	470 ± 10	30 ± 7

Precise measurement of the Weinberng angle

Coherent Elastic Neutrino-Nucleus Scattering (CEvNS) is a **fundamental process** recently observed by the COHERENT collaboration.





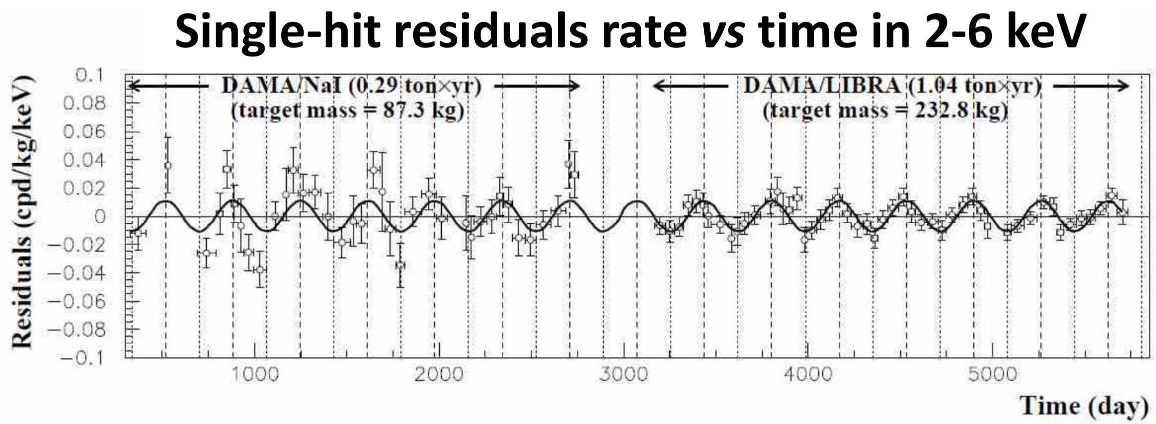
We are discussing **installation of our pilot NaI(Tl) detector to measure CEvNS at the Spallation Neutron Source** (Oak Ridge, Tennessee) **in early 2018**

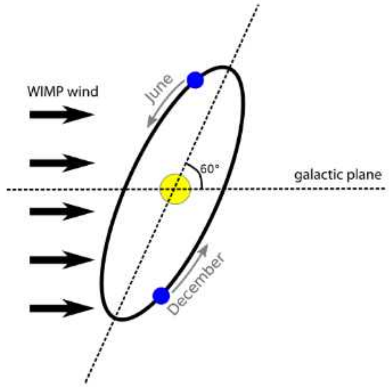
IsoDAR @KamLAND

Since CEvNS cross-section depends on the Weinberg angle ϑ_W, it opens a way to **measure weak mixing angle $\sin^2\vartheta_w$ using a large NaI(Tl) detector**. Such detector can be installed with IsoDAR $\tilde{\nu}_e$ source in Kamioka in early 2020s.

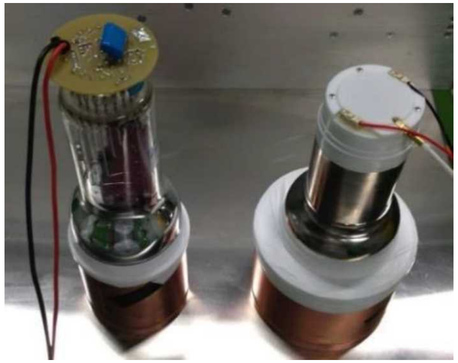
Dark Matter search and test of DAMA/LIBRA observations

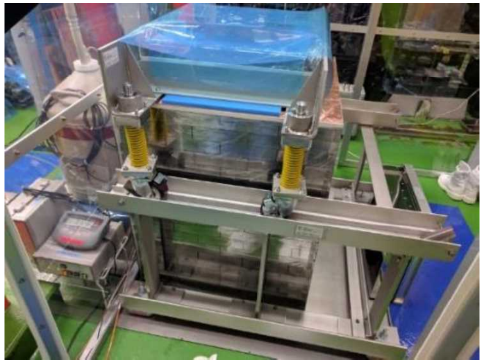
Weakly interacting massive particles are one of the most promising **dark matter candidates**. **The annual modulation signal** claimed by DAMA/LIBRA will be tested using our recently developed ultra-radio-pure NaI(Tl) crystals.

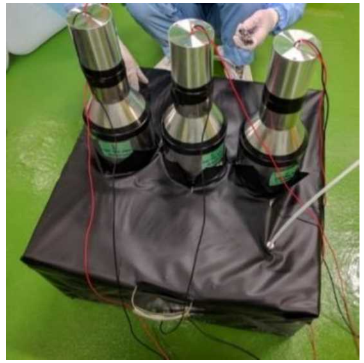




We will also look for possible correlations between the several keV signals in NaI(Tl) detectors, the radon activity in the mine air and the neutron flux.







Full-size NaI(Tl) detector construction will start in 2018

RH neutrino dark matter: a flavoured *B-L* model

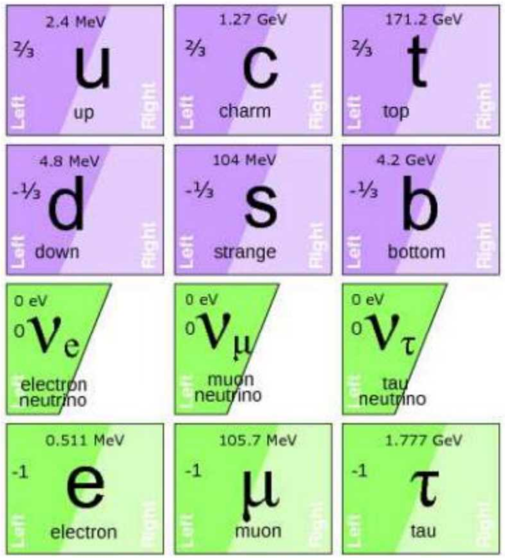
Peter Cox

Kavli IPMU

In collaboration with Chengcheng Han, Tsutomu T. Yanagida

Right-handed Neutrinos

- Simple, well-motivated extension of Standard Model is addition of $3\ \nu_R$



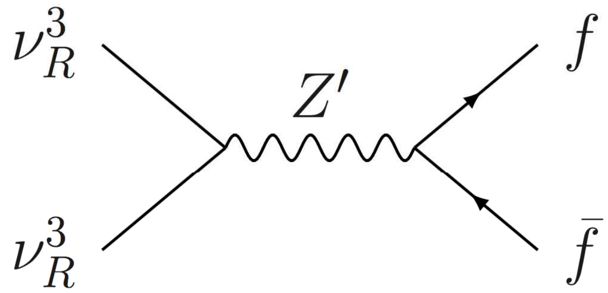
- Two very heavy ν_R ($\mathrm{M} \gtrsim 10^9$ GeV) can explain:
  - Smallness of active neutrino masses via seesaw mechanism
  - Observed baryon asymmetry via leptogenesis

- Lightest ν_R can provide a dark matter candidate!

$U(1)_{(B-L)_3}$ gauge symmetry

- ν_R^3 can be thermally produced in early universe by introducing new gauge interactions

$$SU(3)_C \times SU(2)_L \times U(1)_Y \times U(1)'$$

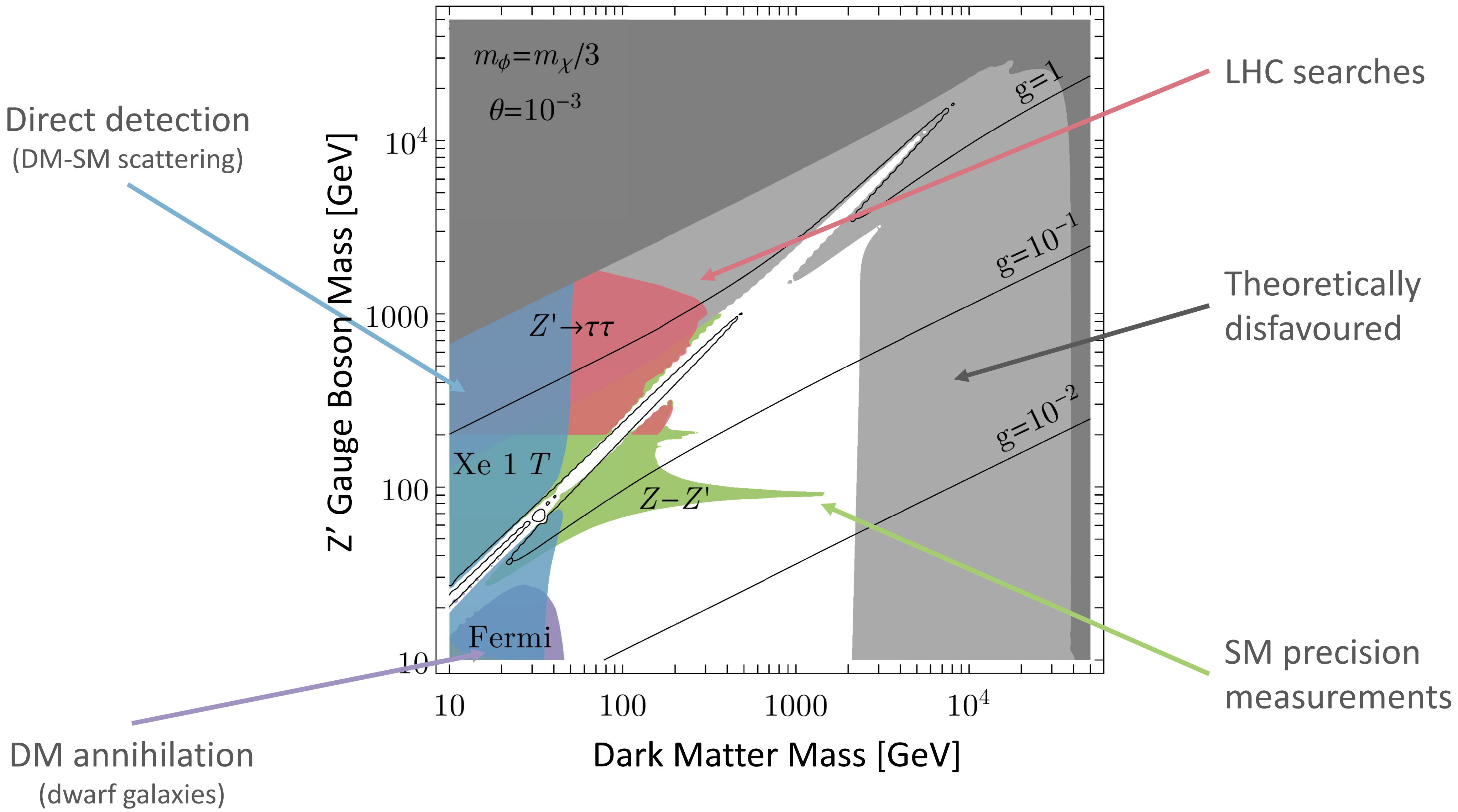


- We consider a *flavoured* $U(1)\ B-L$ symmetry
    - Only 3rd family of quarks and leptons are charged

	$q_L^3,\ b_R,\ t_R$	$\ell_L^3,\ \tau_R,\ \nu_R^3$	H
$Q_{(B-L)_3}$	+1/3	-1	0

- ν_R^3 mass generated by spontaneous symmetry breaking

The current status



" Contractibility in algebraic geometry "

Will Donovan

Algebraic varieties

Spaces of solutions to polynomials

Question

Given subvariety, is it **contractible**?

Algebraic varieties

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$$xy = z$$

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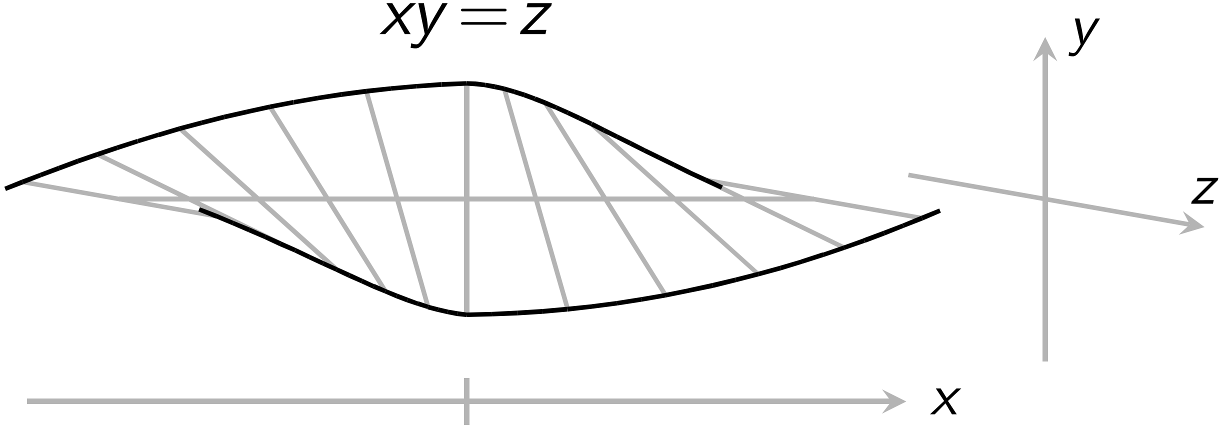

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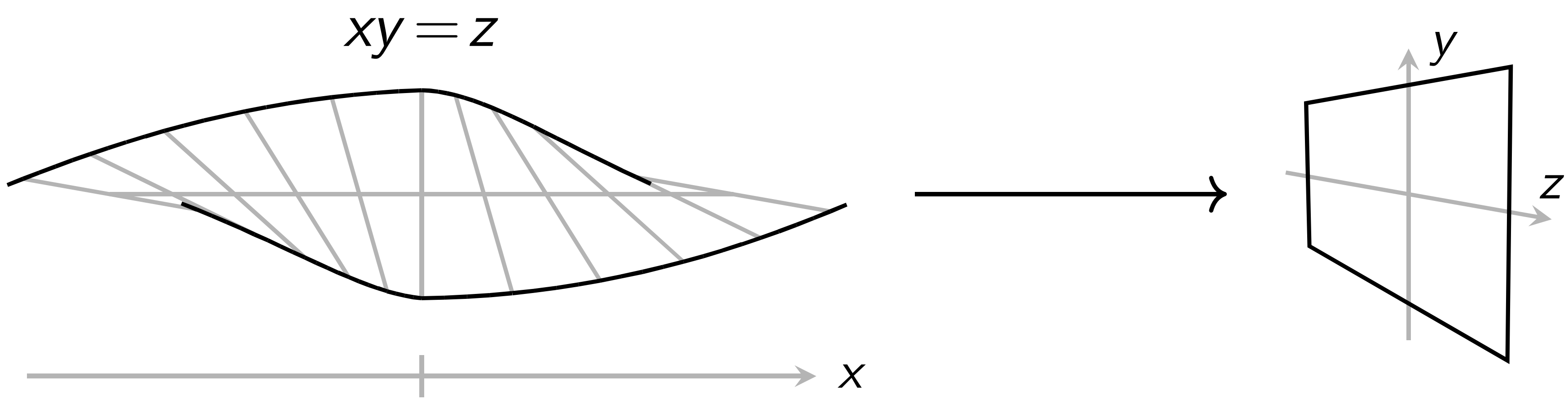

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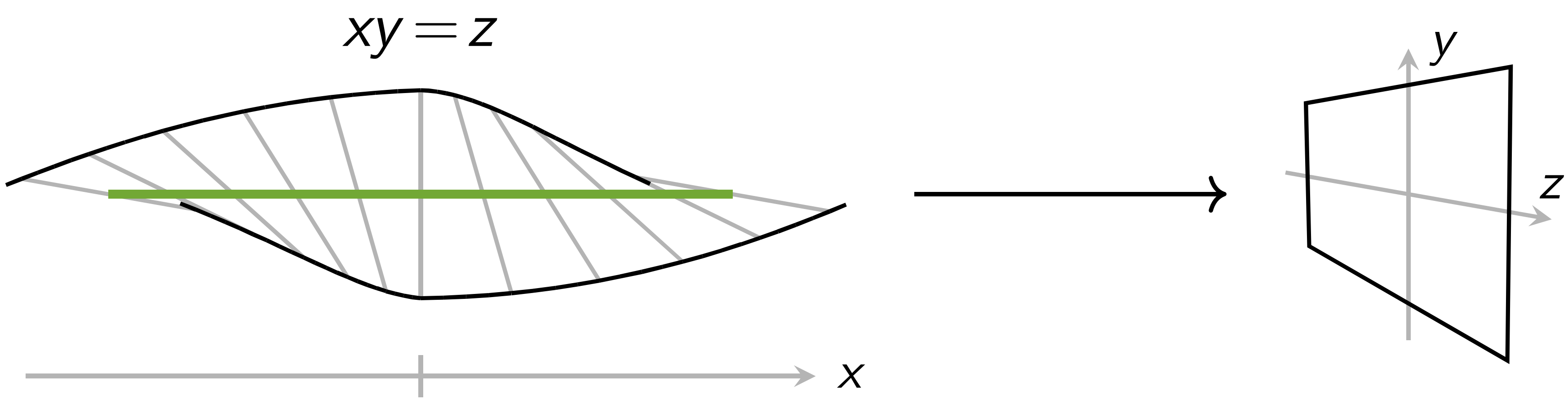

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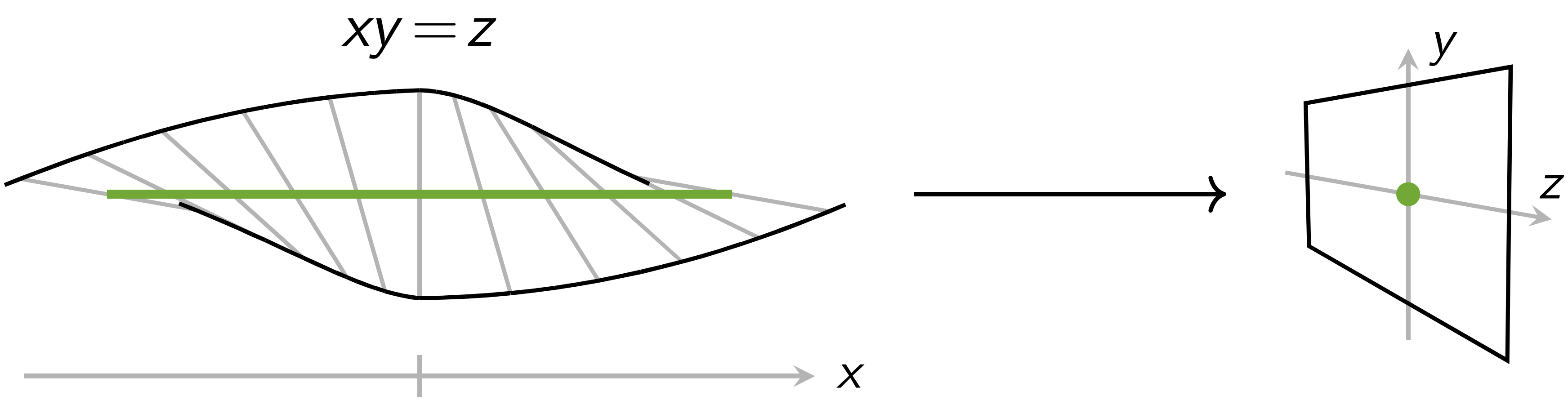

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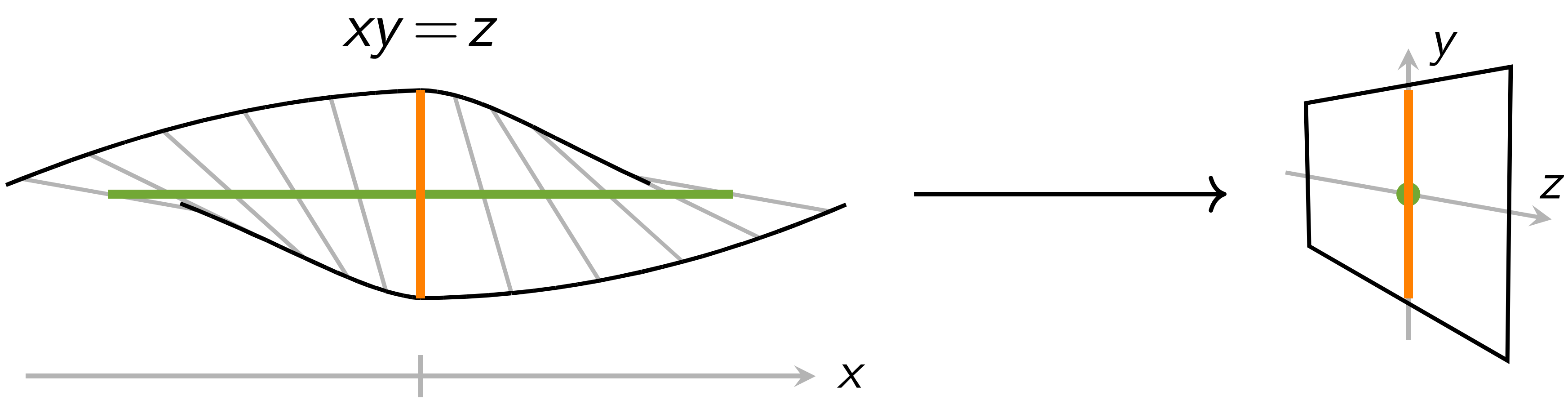

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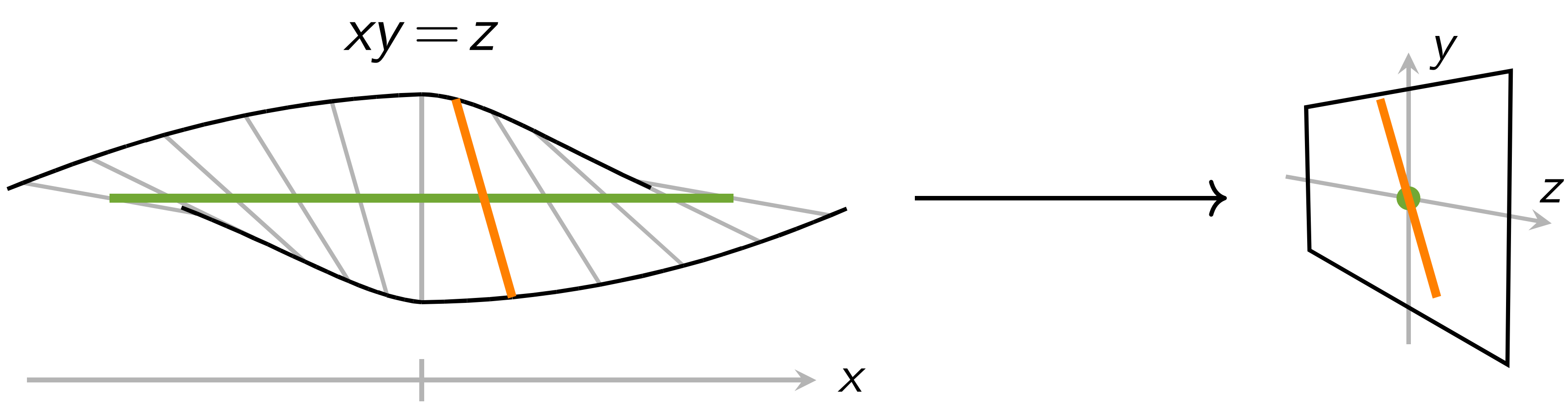

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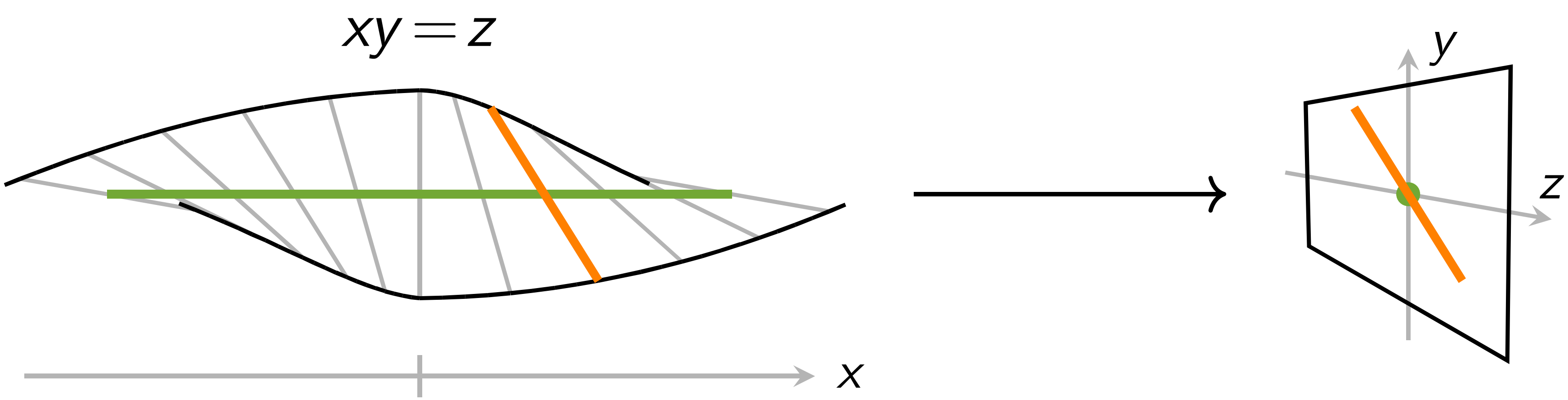

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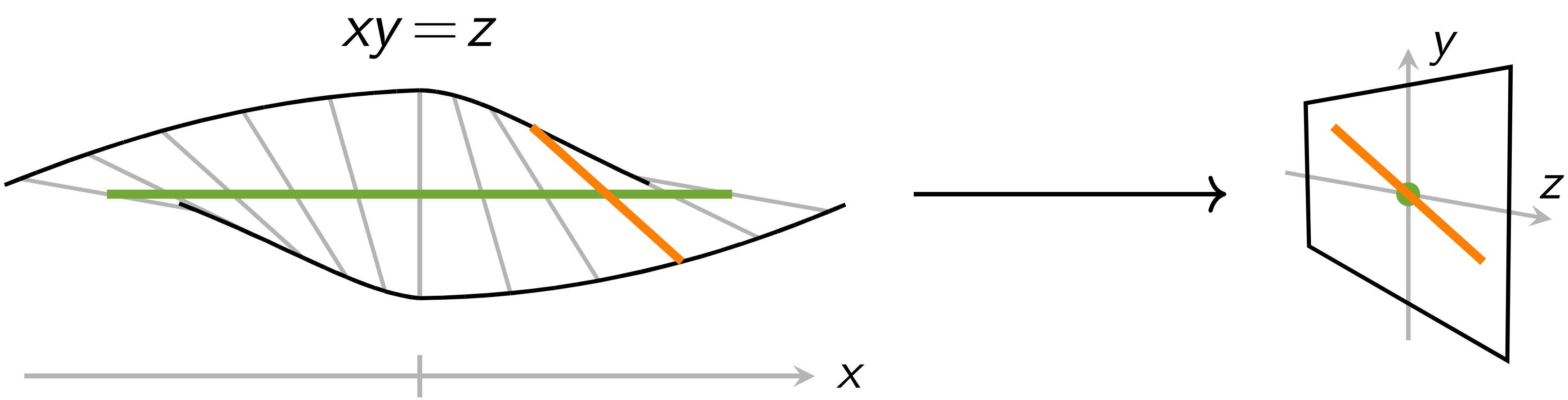

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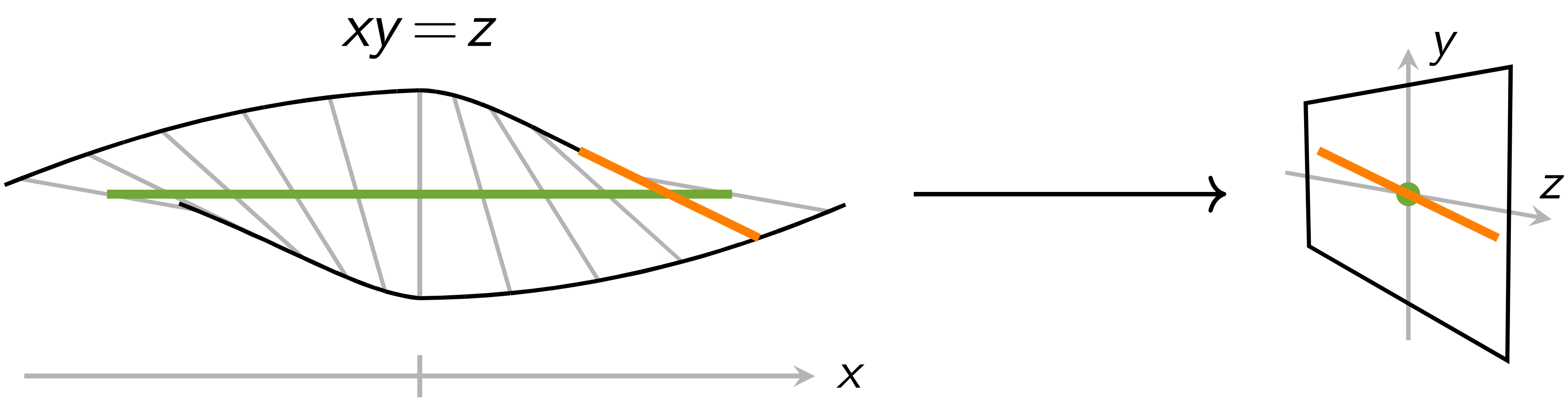

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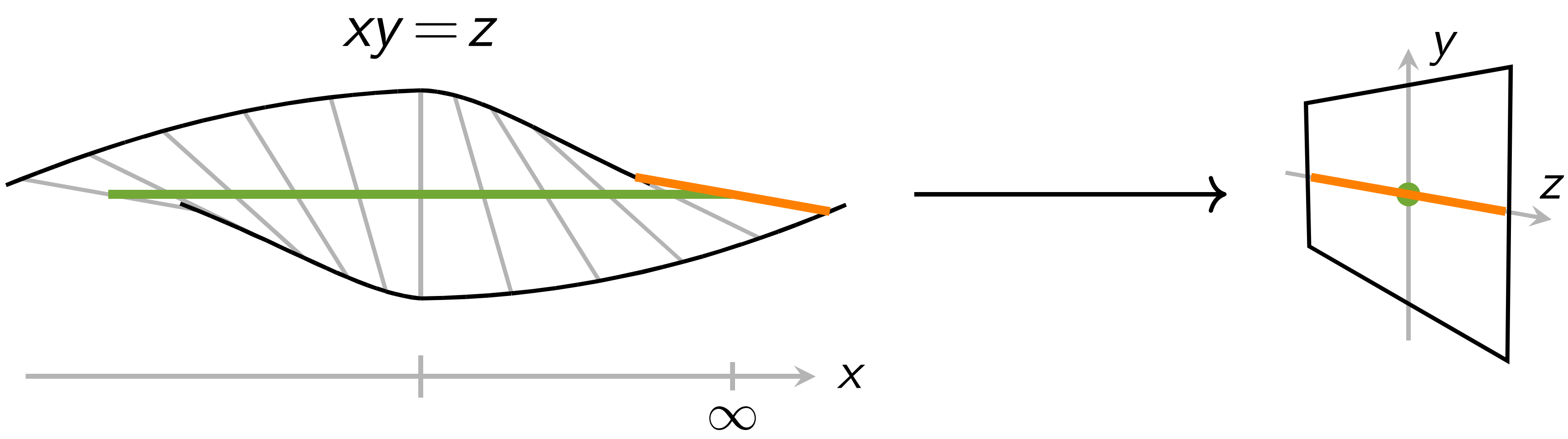

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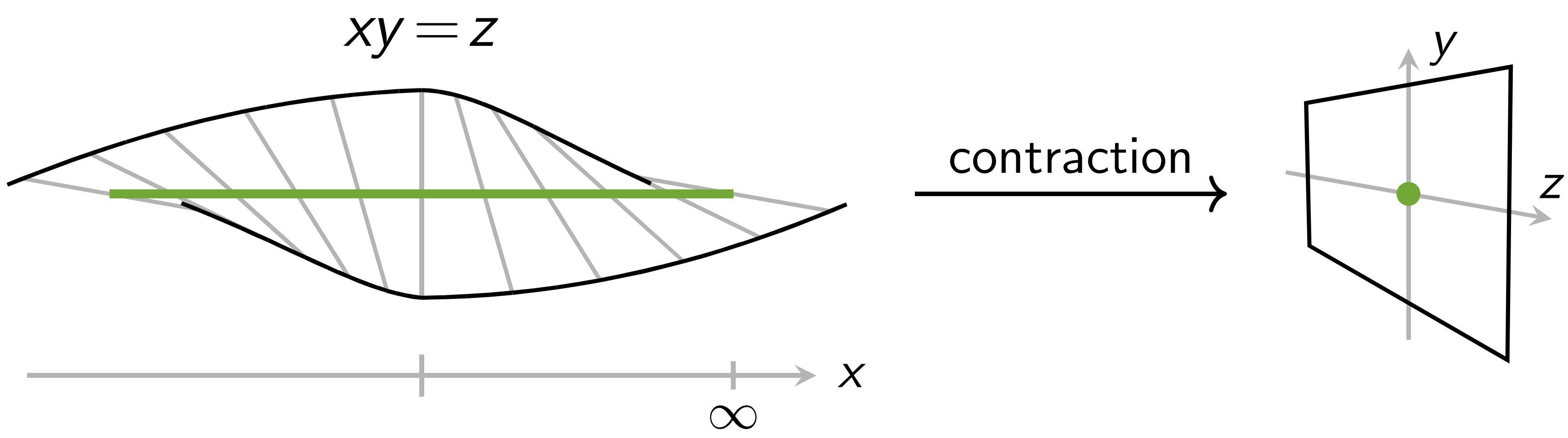

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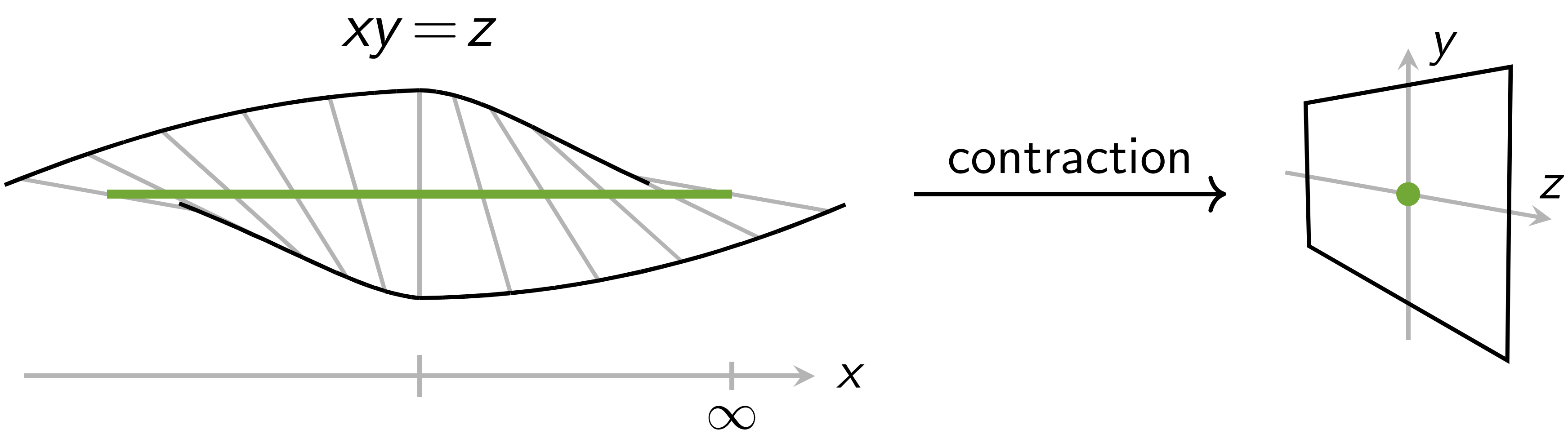

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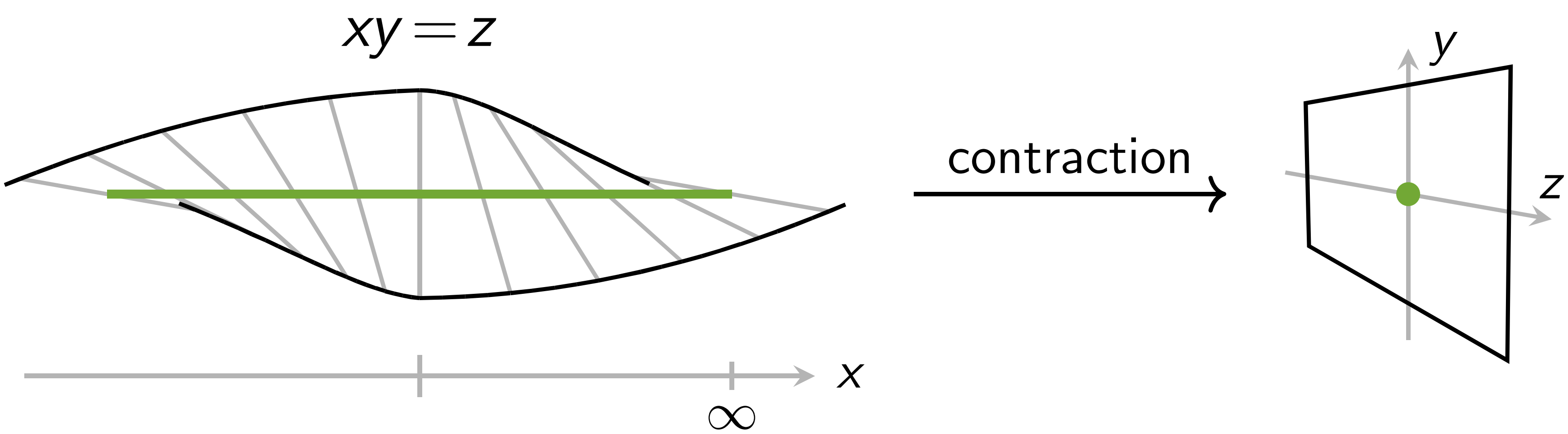
Algebraic varieties over $\mathbb{C}$

Spaces of solutions to polynomials in complex numbers



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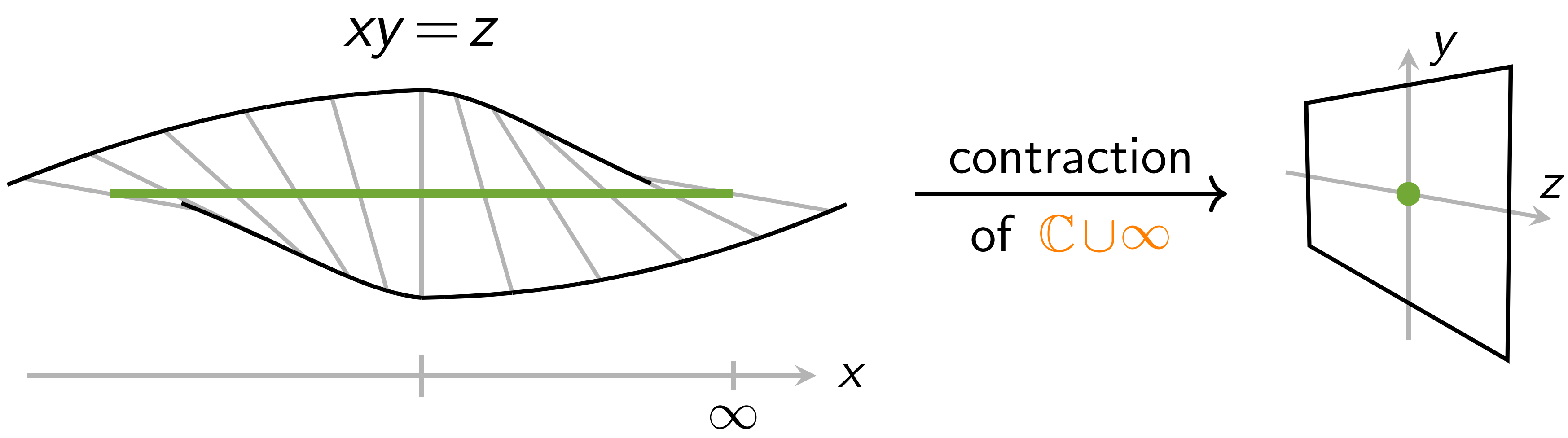

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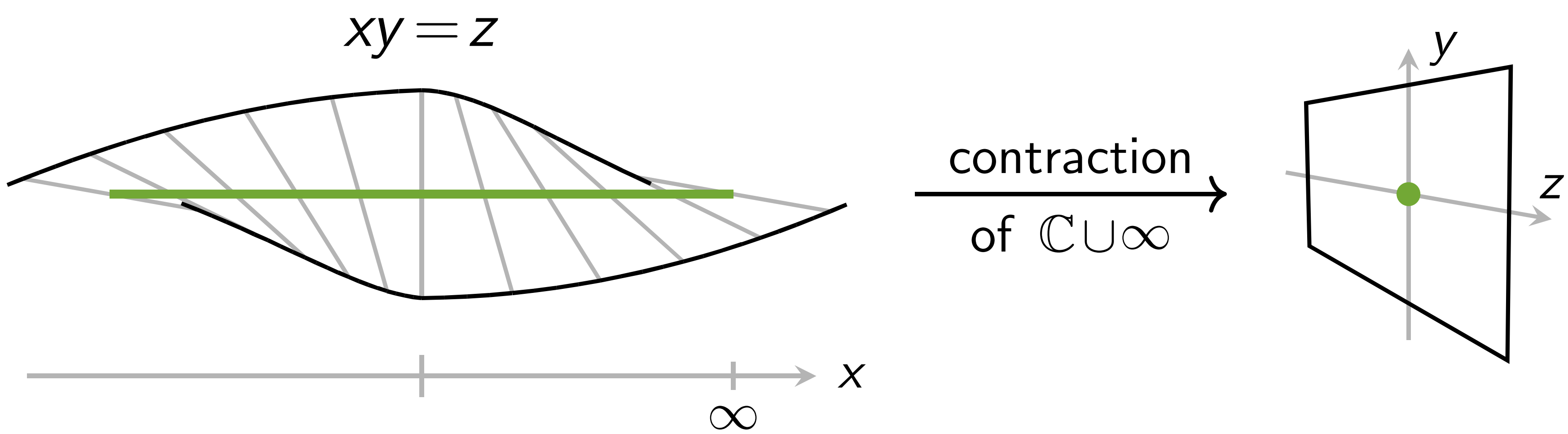

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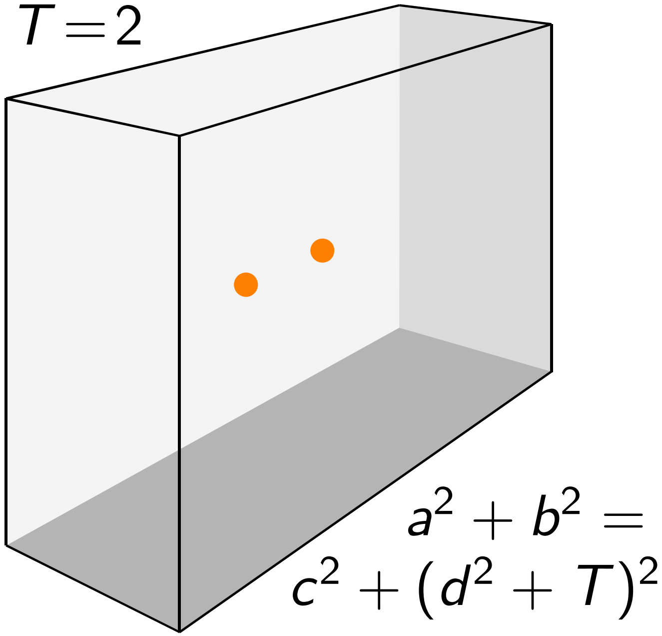


Definition

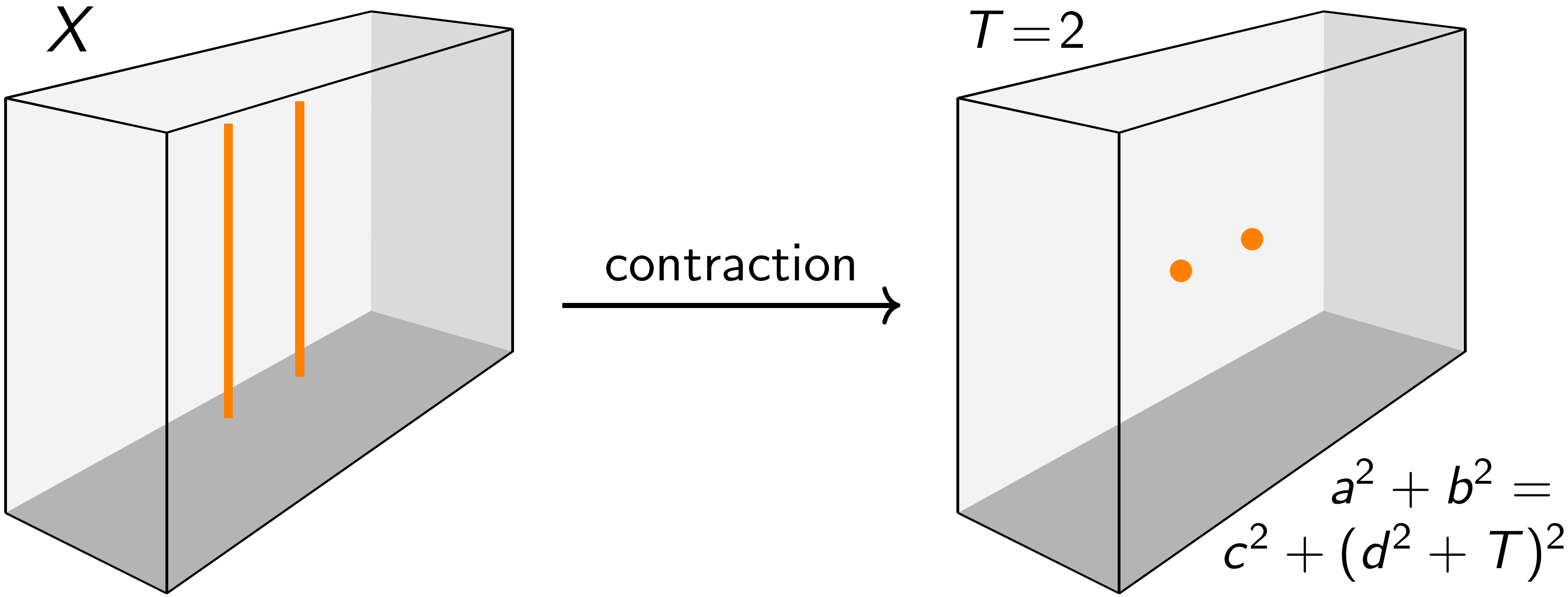
$\mathcal{A}$: deformation **algebra** for $Y = \mathbb{C} \cup \infty$

Theorem

$\mathcal{A}$ induces **derived symmetry** of X Toda, D–Wemyss

Theorem

$\mathcal{A}$ finite-dimensional iff Y **contractible**



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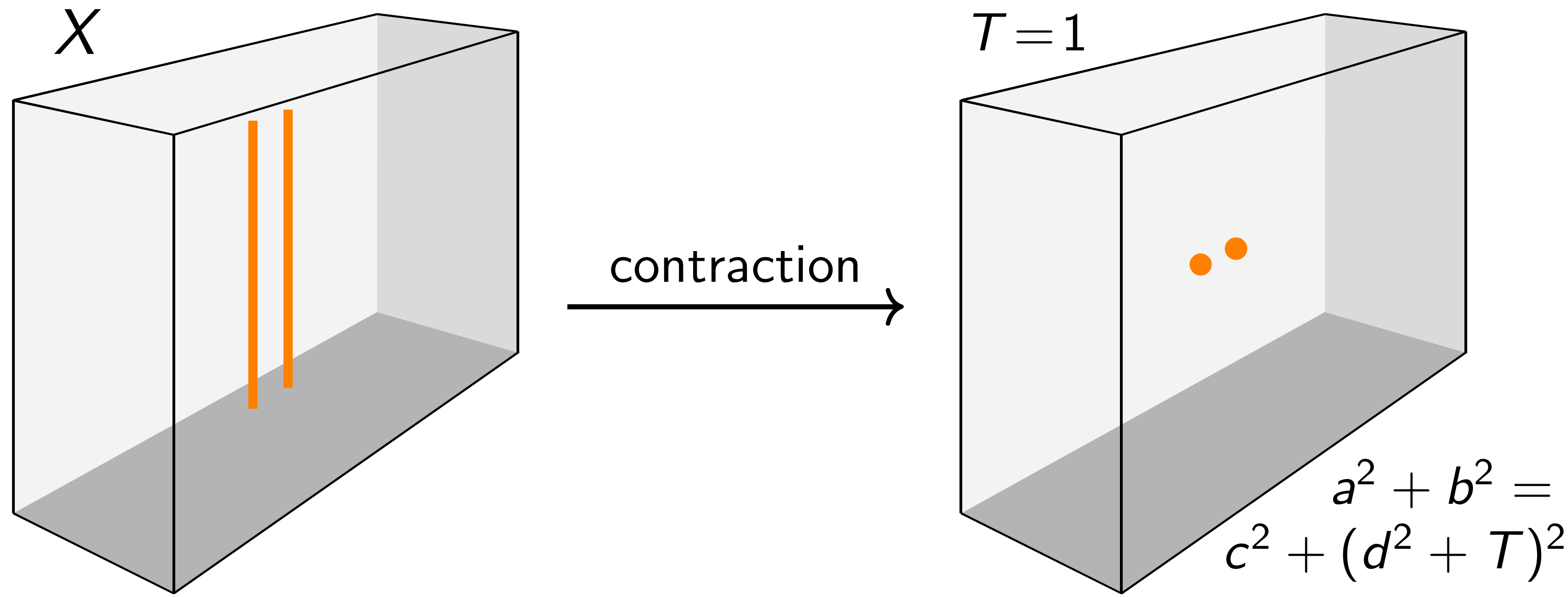

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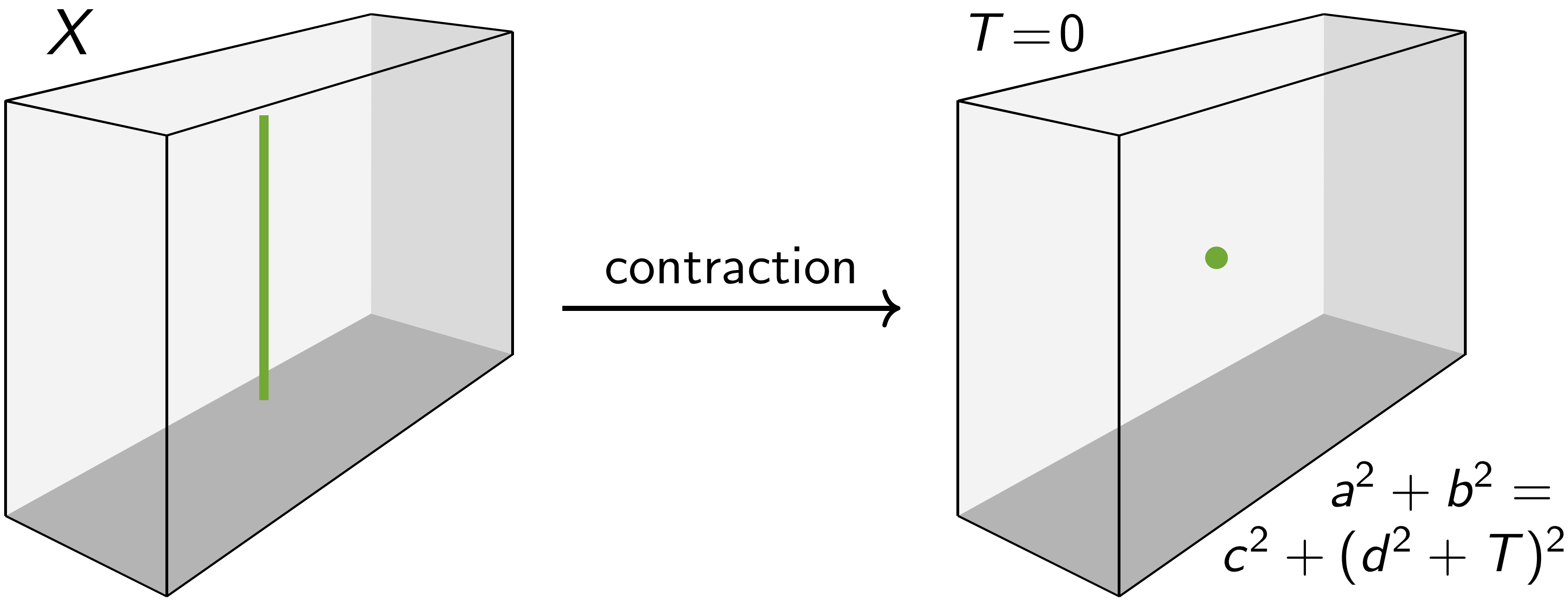

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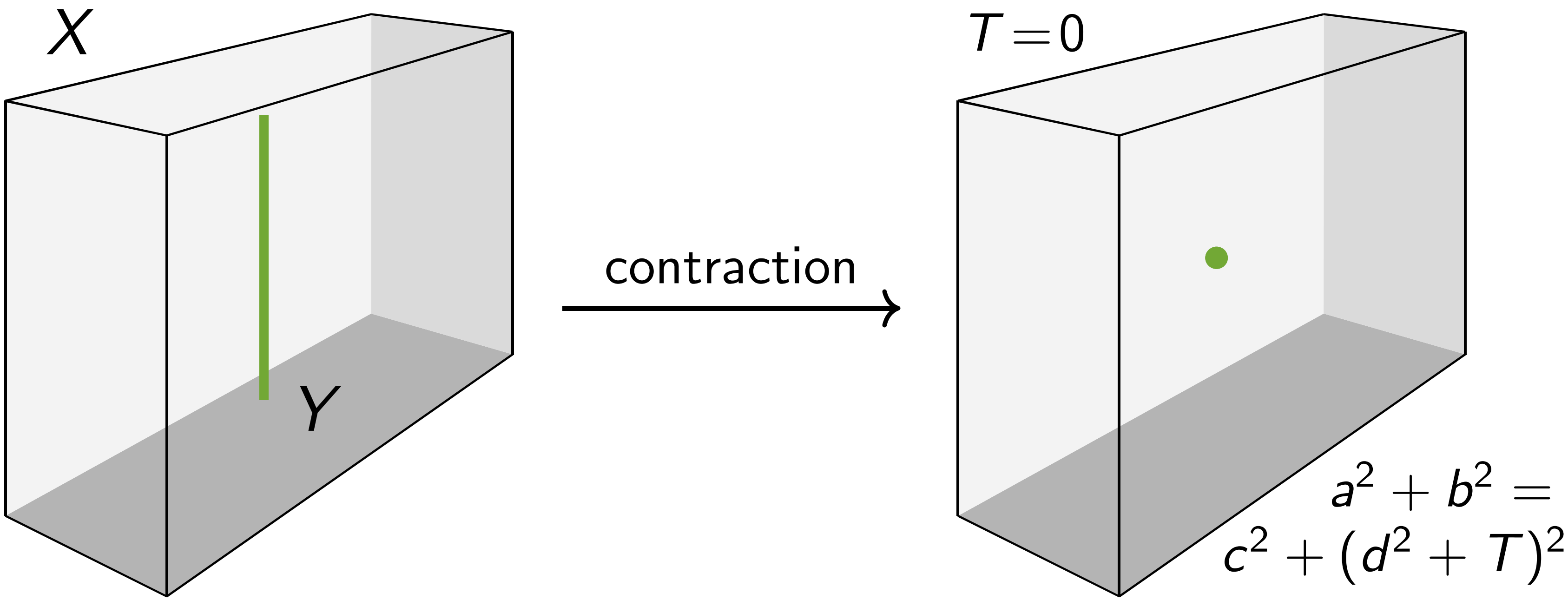

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Toda, D–Wemyss

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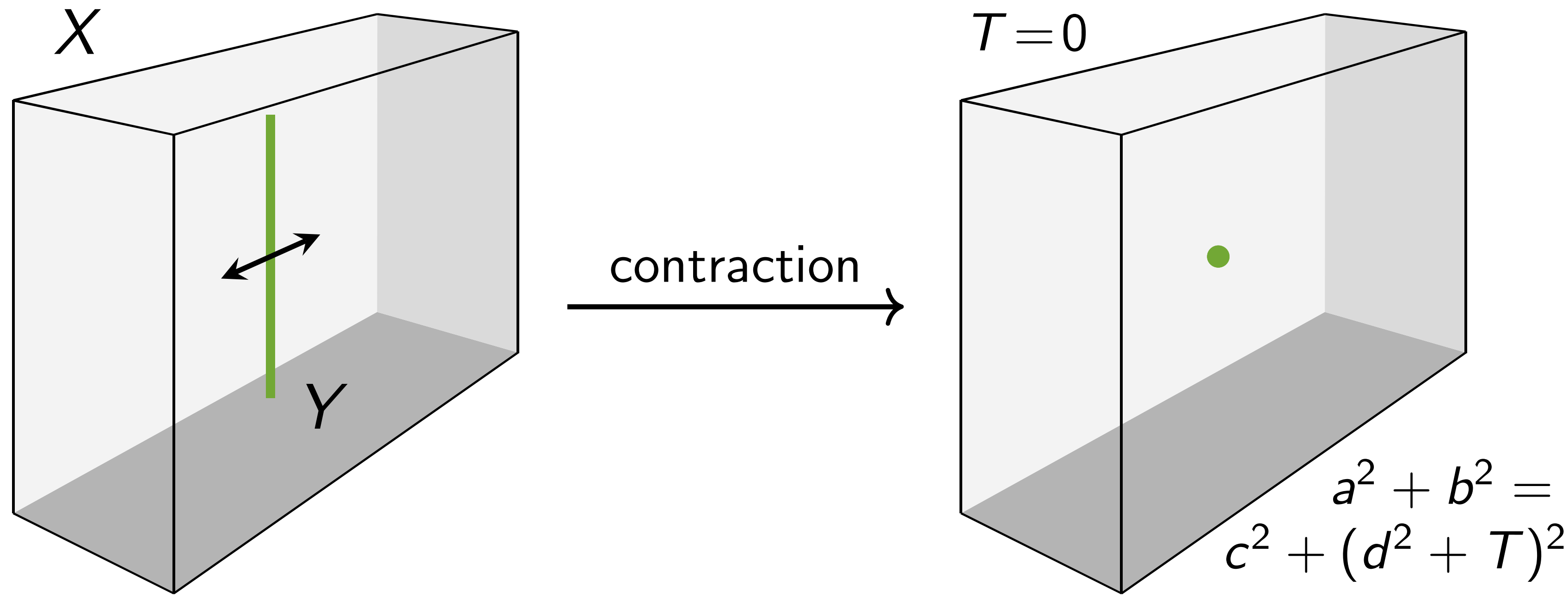

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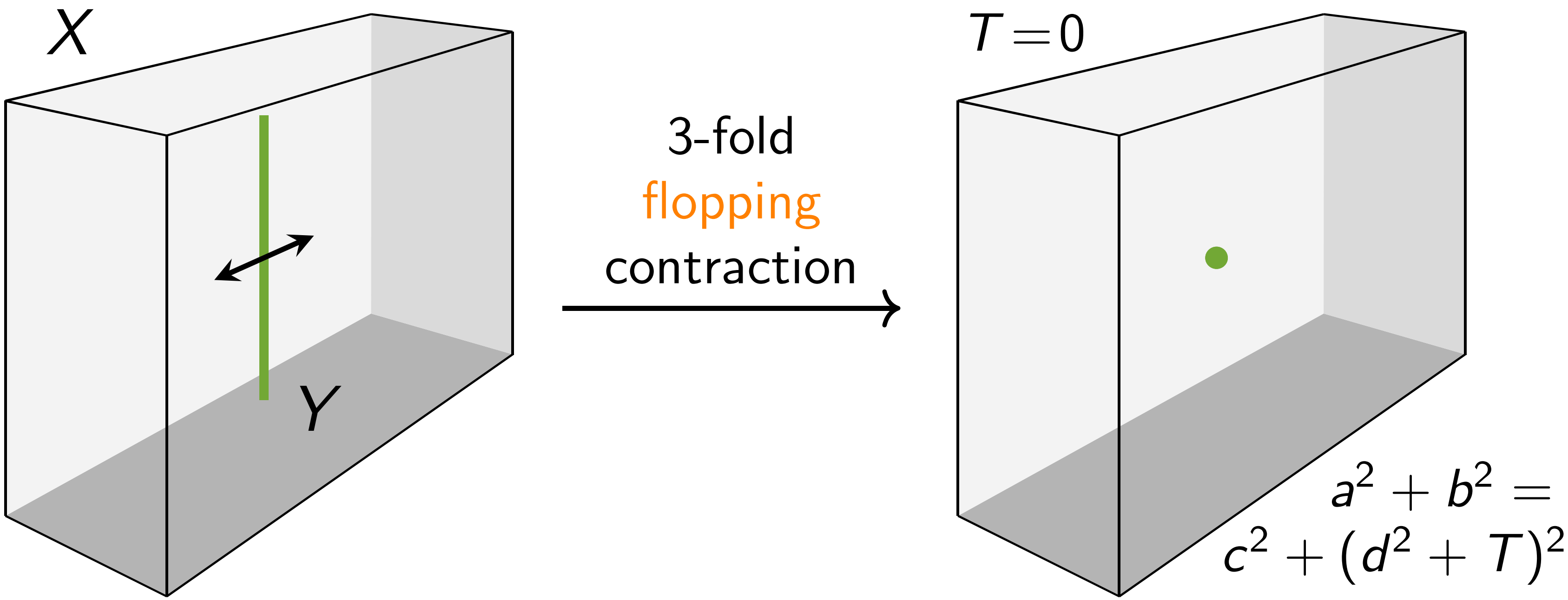

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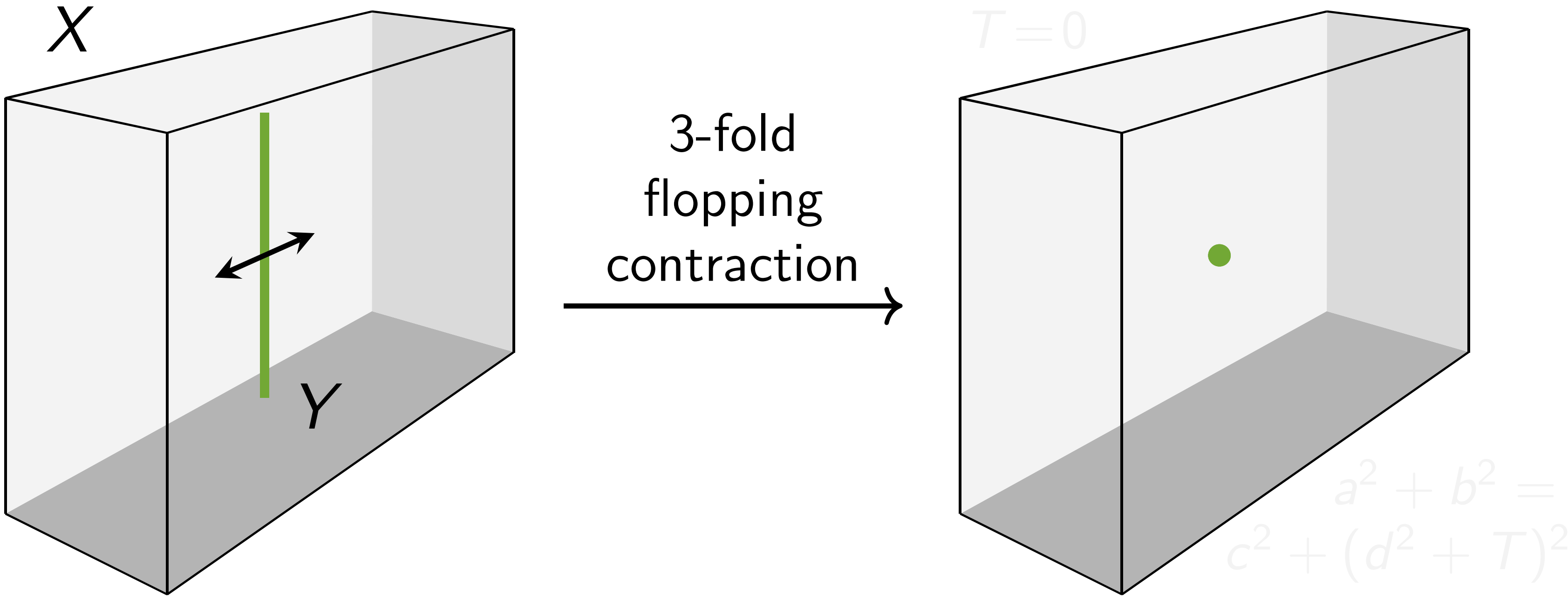

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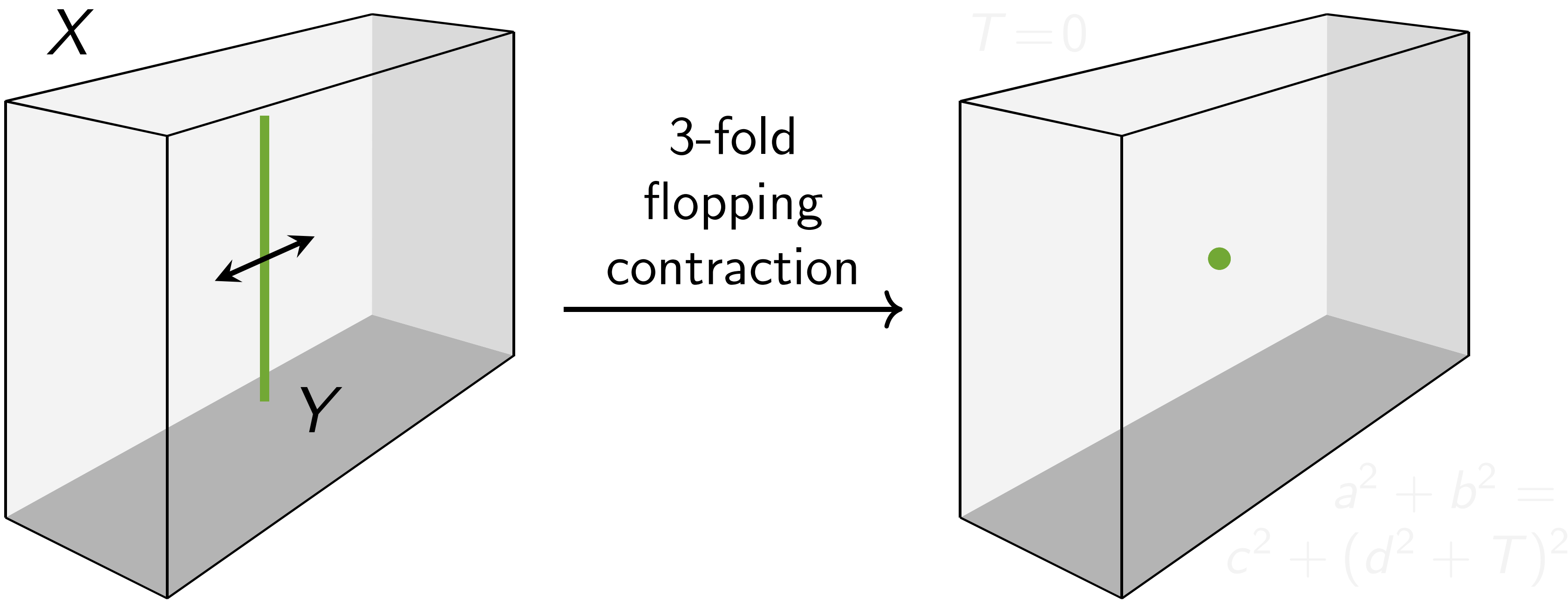

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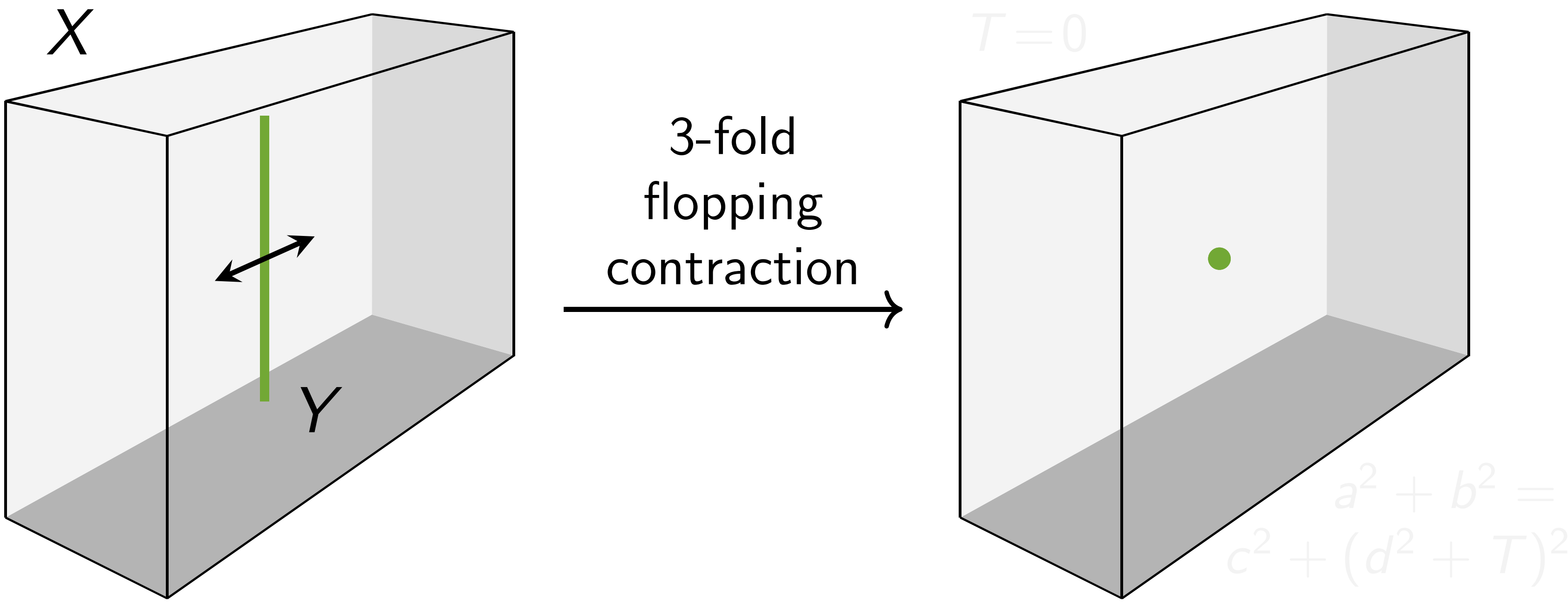

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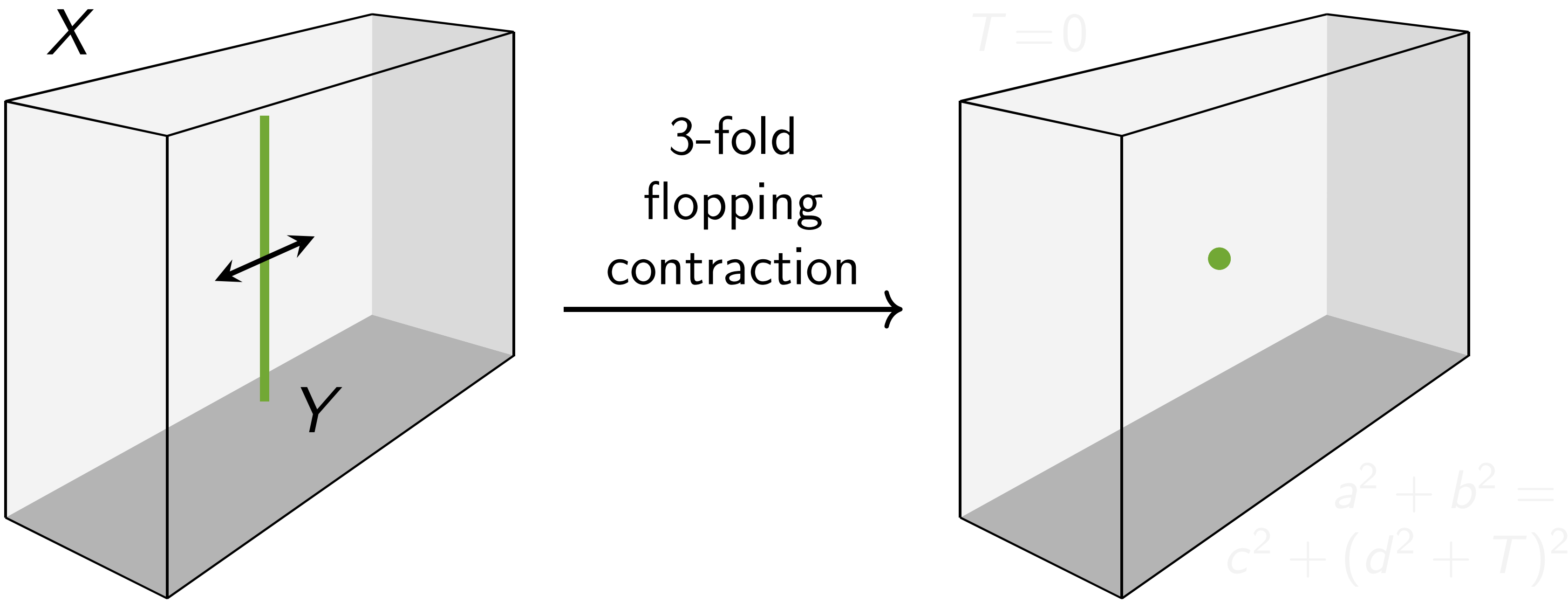

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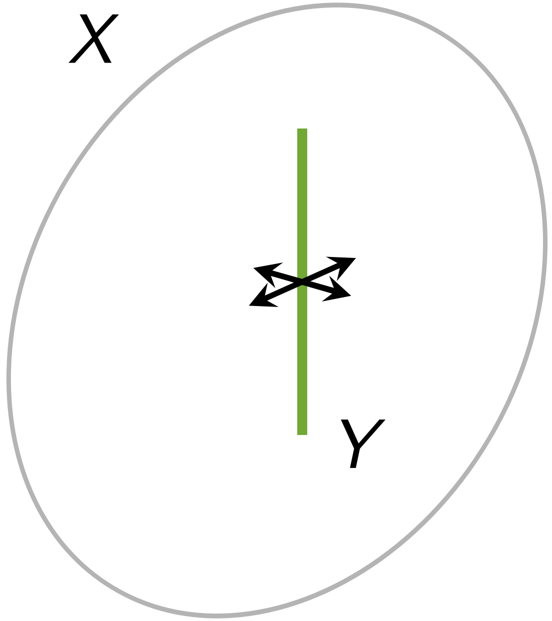

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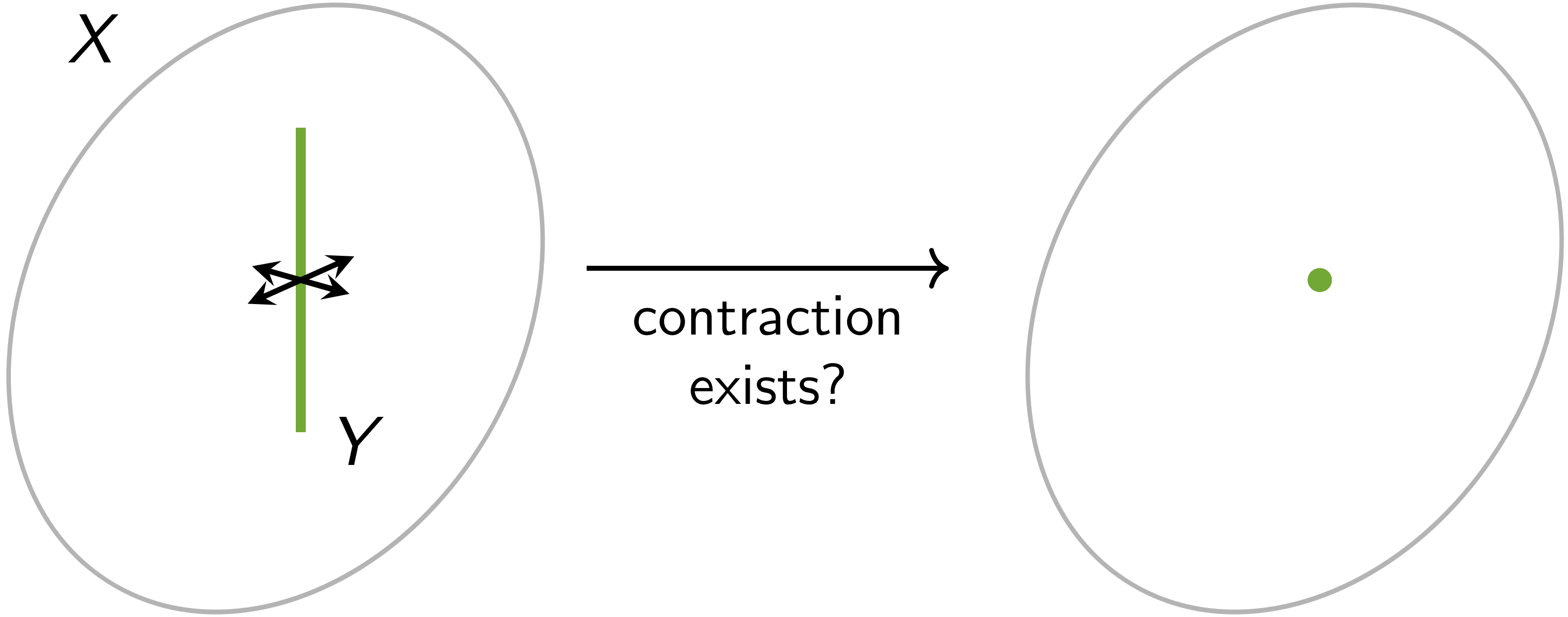

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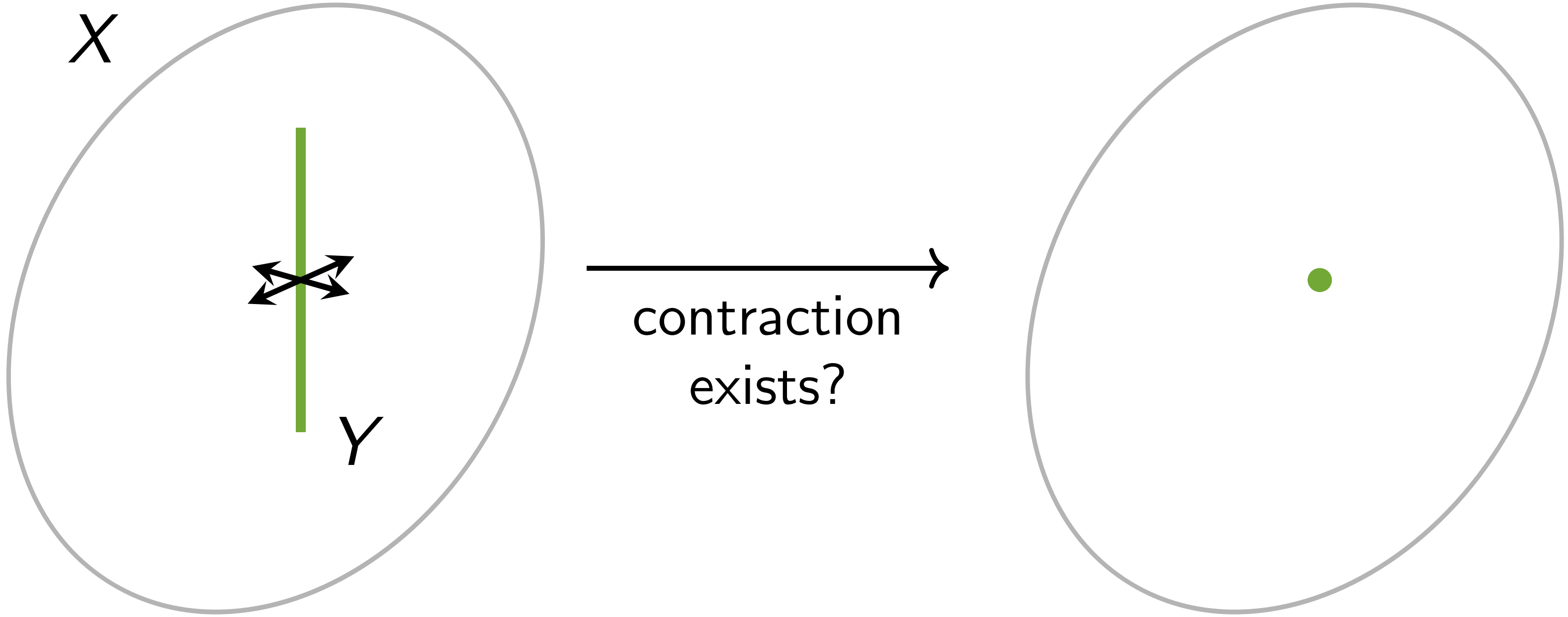

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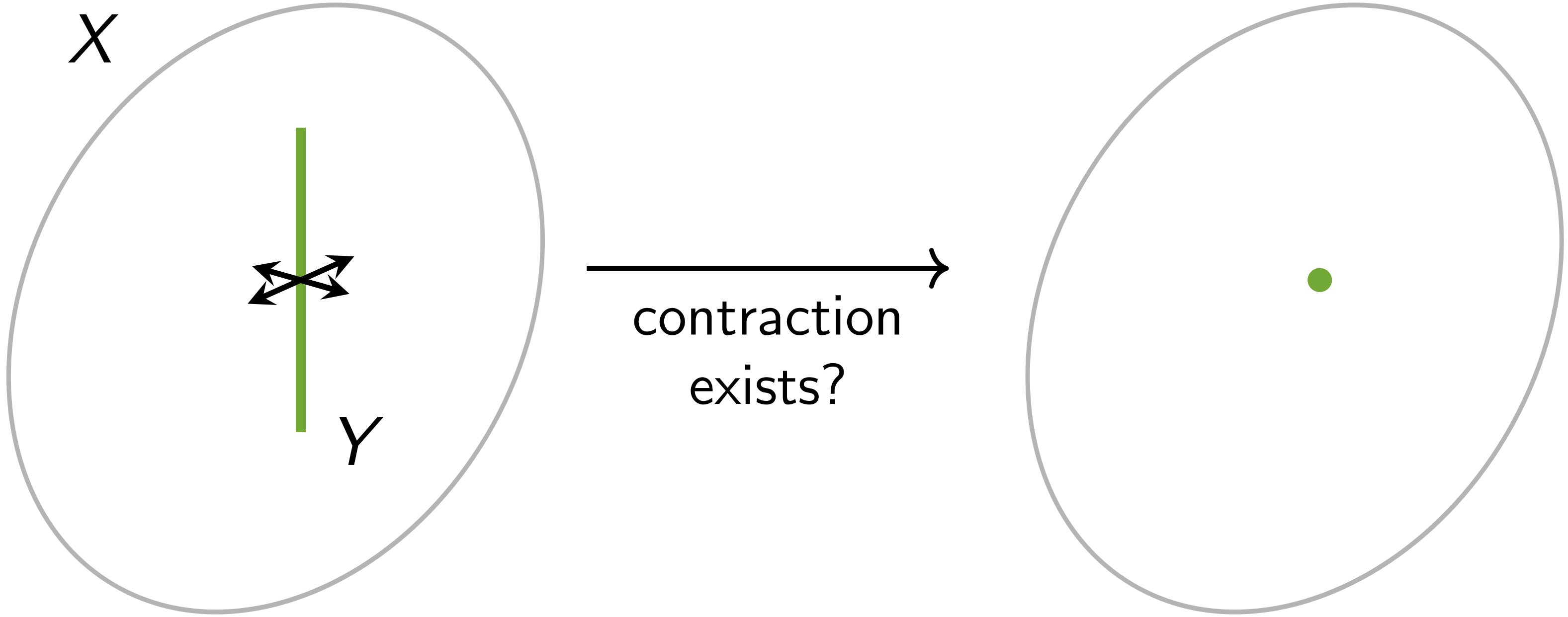

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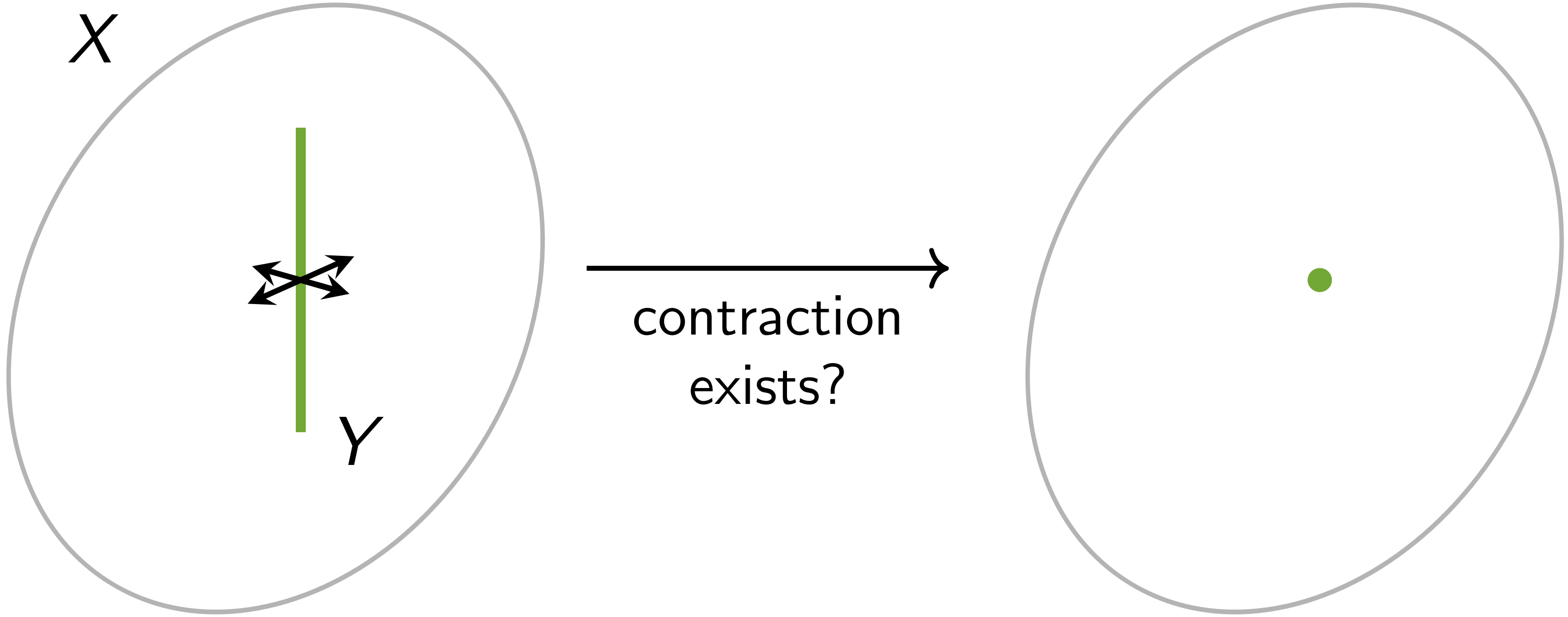
Reid, D–Wemyss



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A novel constraint on ultralight dark matters

In preparation

Hajime Fukuda, S. Matsumoto, T.T. Yanagida

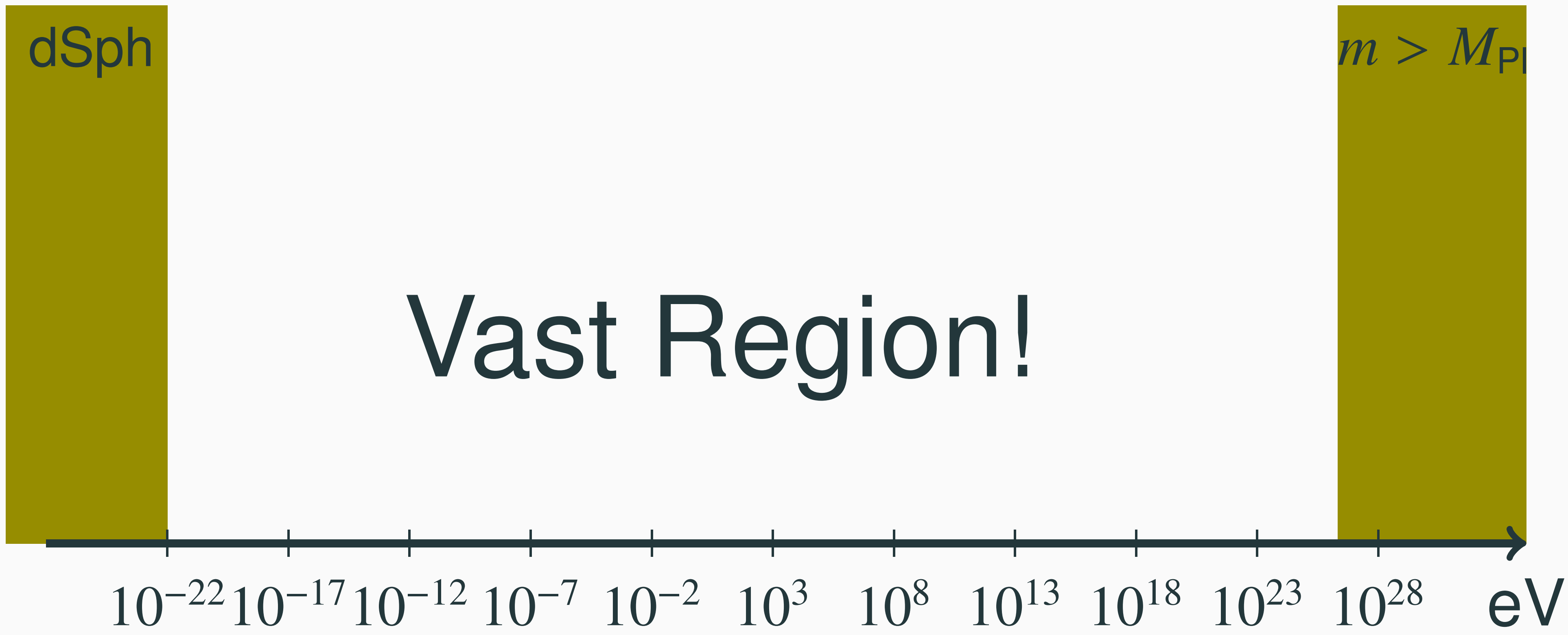
October 11, 2017

Kavli IPMU, U. Tokyo

Introduction

- Dark matter is one of the most rigid new physics
- Which mass range?

Particle DM Mass Range



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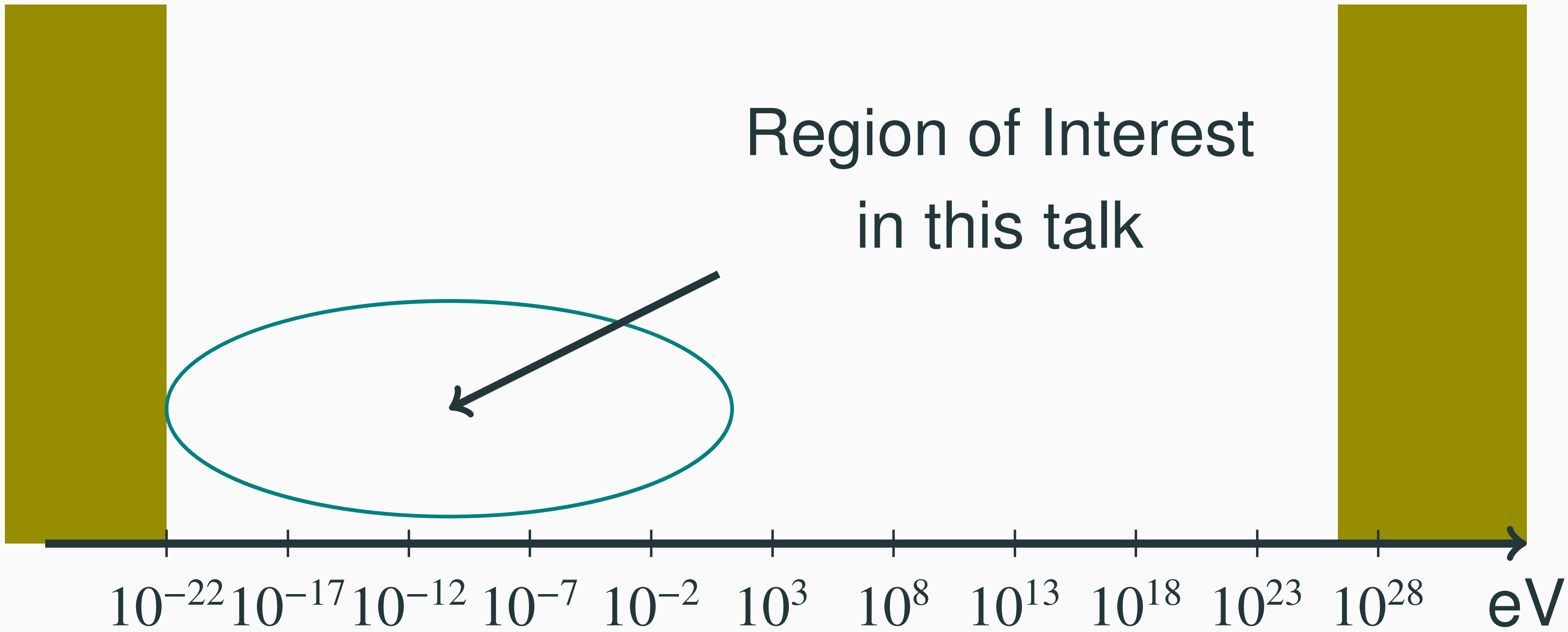


Ultralight DM (a.k.a. Fuzzy DM)

- DM for 10^{-22} eV $\lesssim m_{\text{DM}} \lesssim$ eV
- Must be Bosonic
- Advantages in the small scale structure over WIMP
  Hu, *et al.*, 2000
- May be from moduli d.o.f.

Most Important Point

- How could we detect them?
  - Production - $\times$
  - Indirect Detection - $\times$ (or $\triangle$)
  - **Direct Detection**

Direct Detection

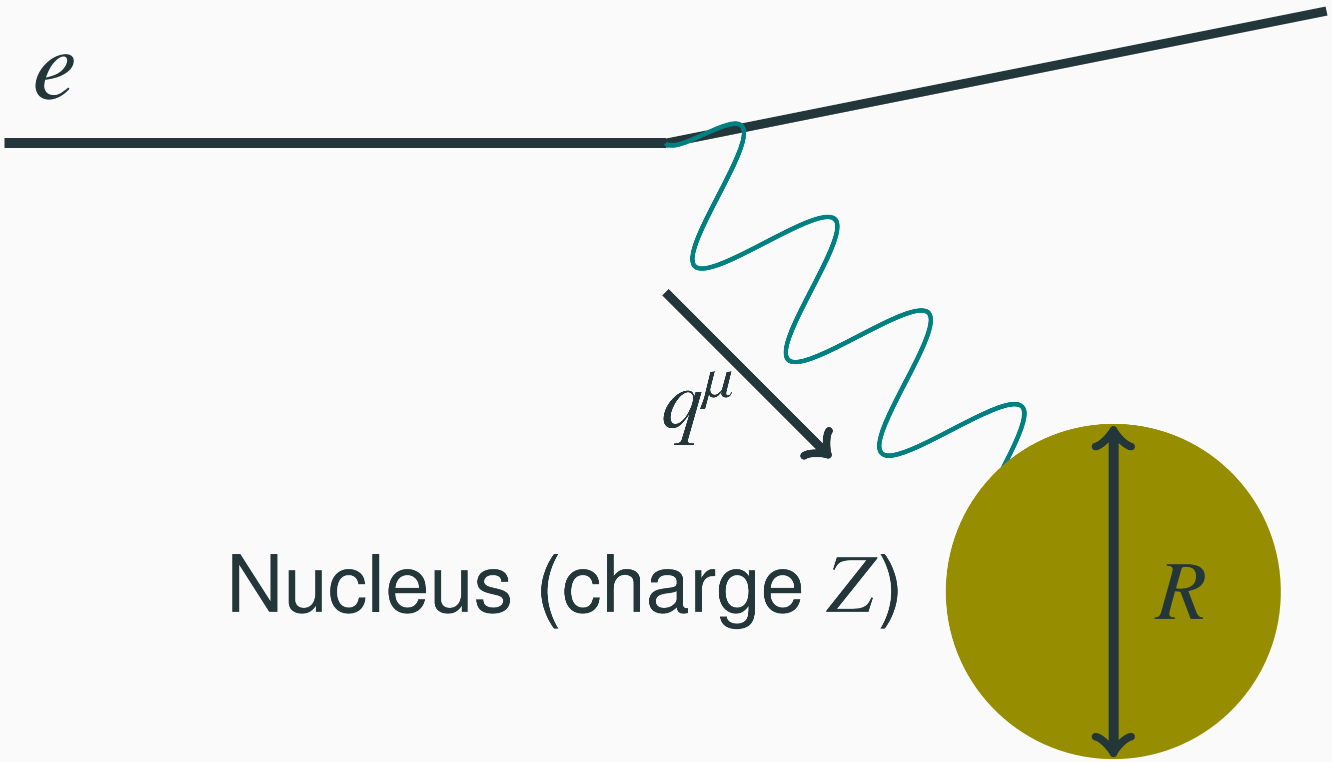
- One recoil may be small
    - Not enough to detect itself
- However, n_{DM} is quite large
- **What is an appropriate target?**
    - Measurement must be precise enough
    - Large enhancement

Enhancement Effect

- The cross section gets enhanced by
  - Stimulated emission
    - We don't include since DM distribution is unknown
  - **Coherent effect on the target**

Coherent Effect

- e.g. Coulomb scattering



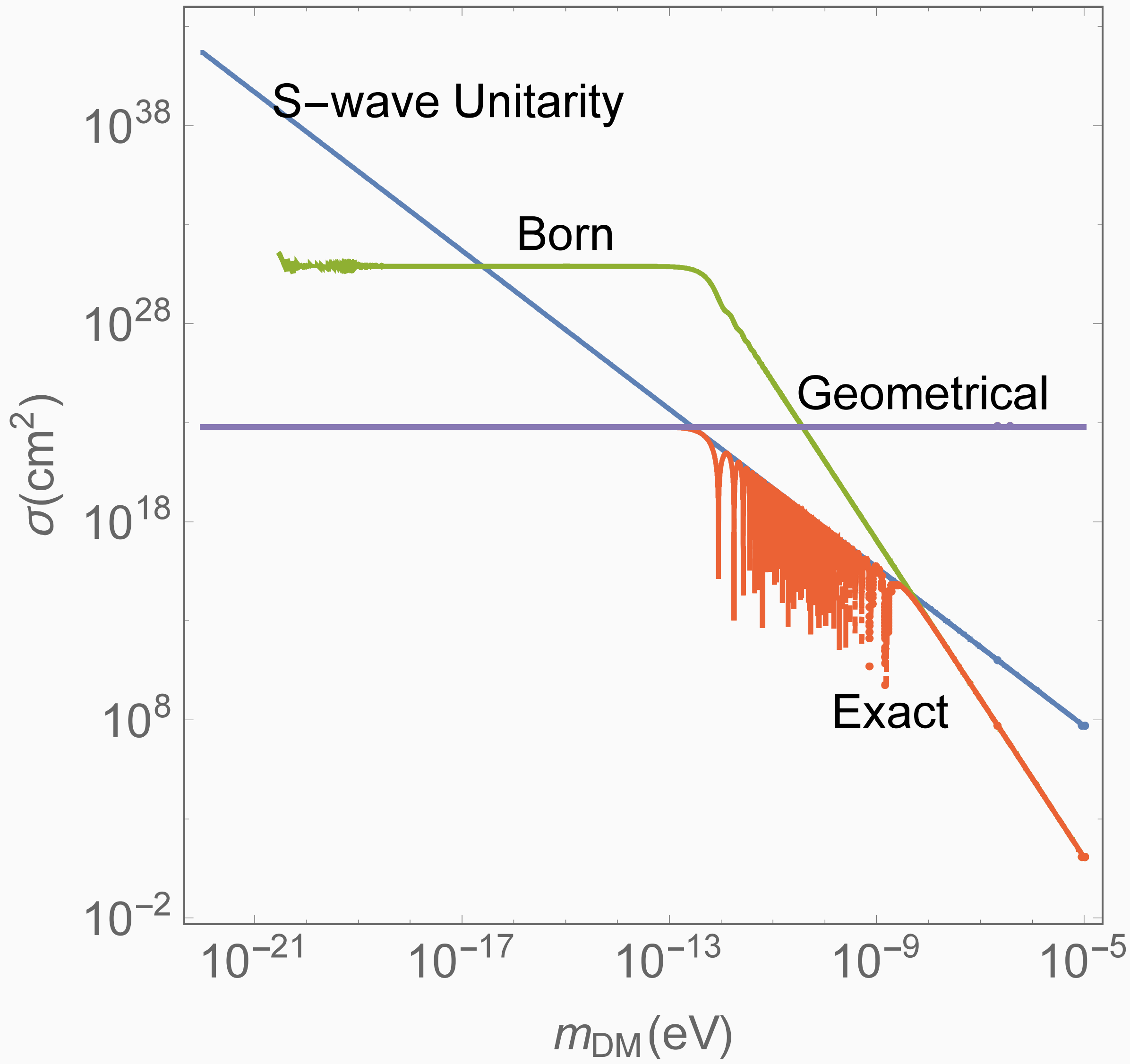
- For $qR < 1$, $\sigma \propto Z^2$!

Coherent Effect

- Naively, $\sigma \propto N_{\text{targ}}^2$
- The larger, the better
- **Use planets as the target!**, $N \sim 10^{50\text{-}58}$
  - Measurement is very accurate, $\Delta v / v \Delta t \lesssim 10^{-(17\text{-}19)}$ s^{-1}
- Born app. fails and N^2 enhancement is no more the case
  - We need to solve Schrödinger eq.

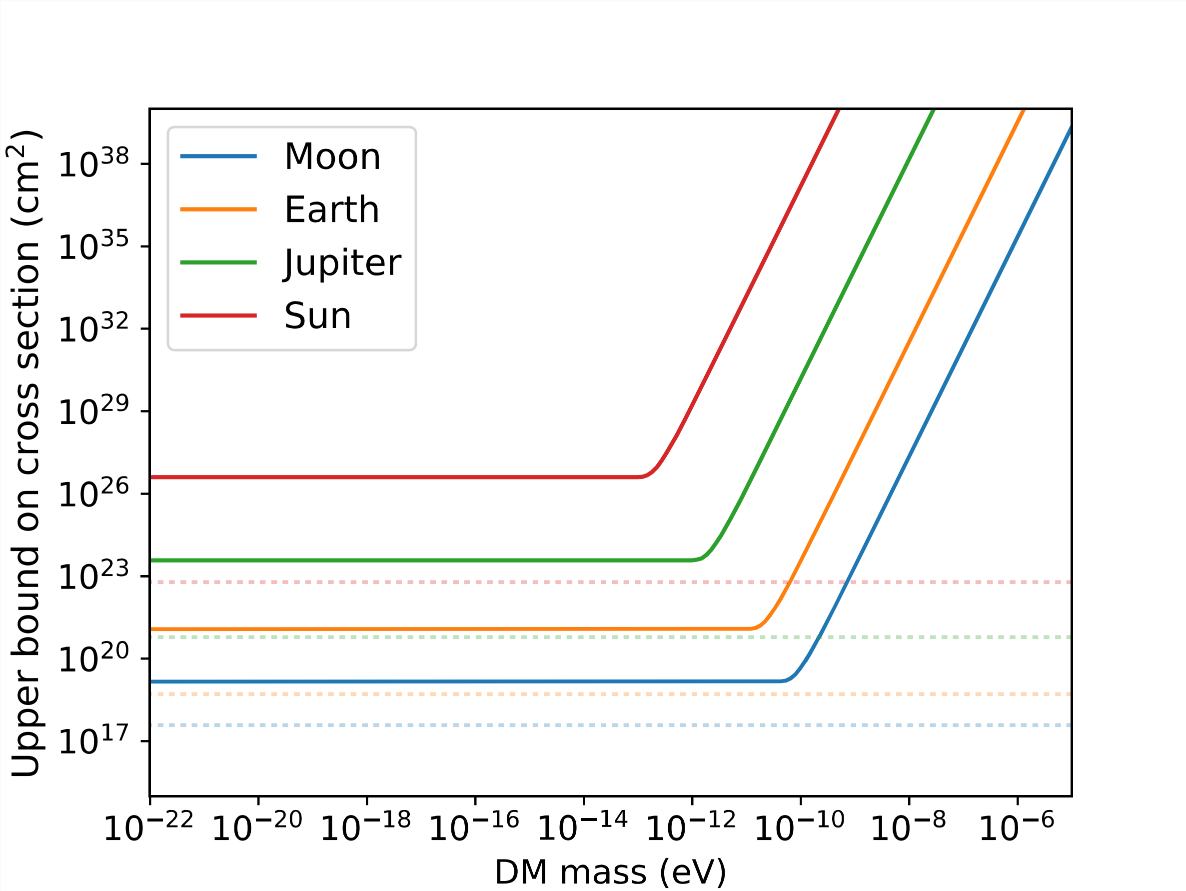
Real Cross Section

- Assuming $\sigma = m^2/(10^{15}\ \mathrm{GeV})^4$



Final Result

- For the best target, we need one order more
  - $\sigma \sim m_{\text{DM}}{}^2/\Lambda^4, \Lambda \sim 10^{13}$ GeV ($m \lesssim 10^{-14}$ eV)



Homological representations of framed braid groups

Akishi Ikeda

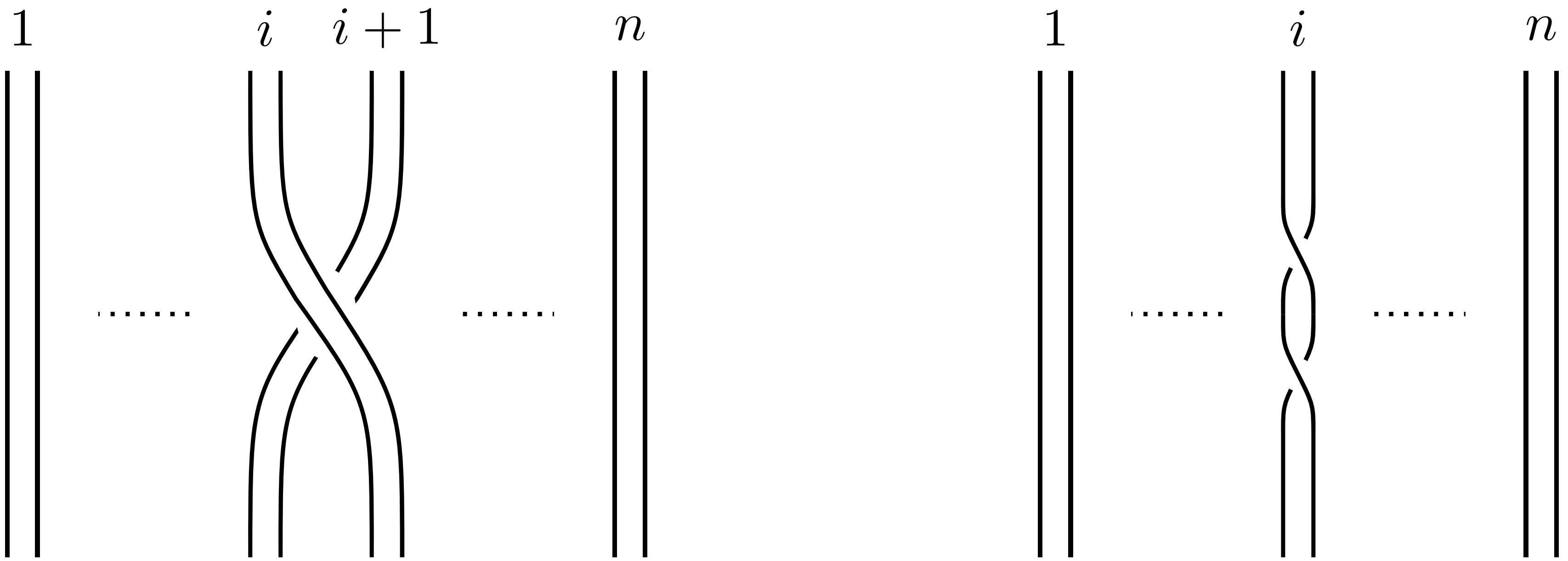
Kavli IPMU

October 17, 2017

Framed braid group

Waht is a framed braid group?

A framed braid group is a mathematical object which describes braiding and twists of ribbons.



Representation

How to study the framed braid group?

To consider **representations** of the framed braid group.

Representation = To represent the group as an algebra of **matrices**

Then the study of the framed group becomes a problem of the **linear algebra**.

Representation

How to study the framed braid group?

To consider **representations** of the framed braid group.

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Representation

How to study the framed braid group?

To consider **representations** of the framed braid group.

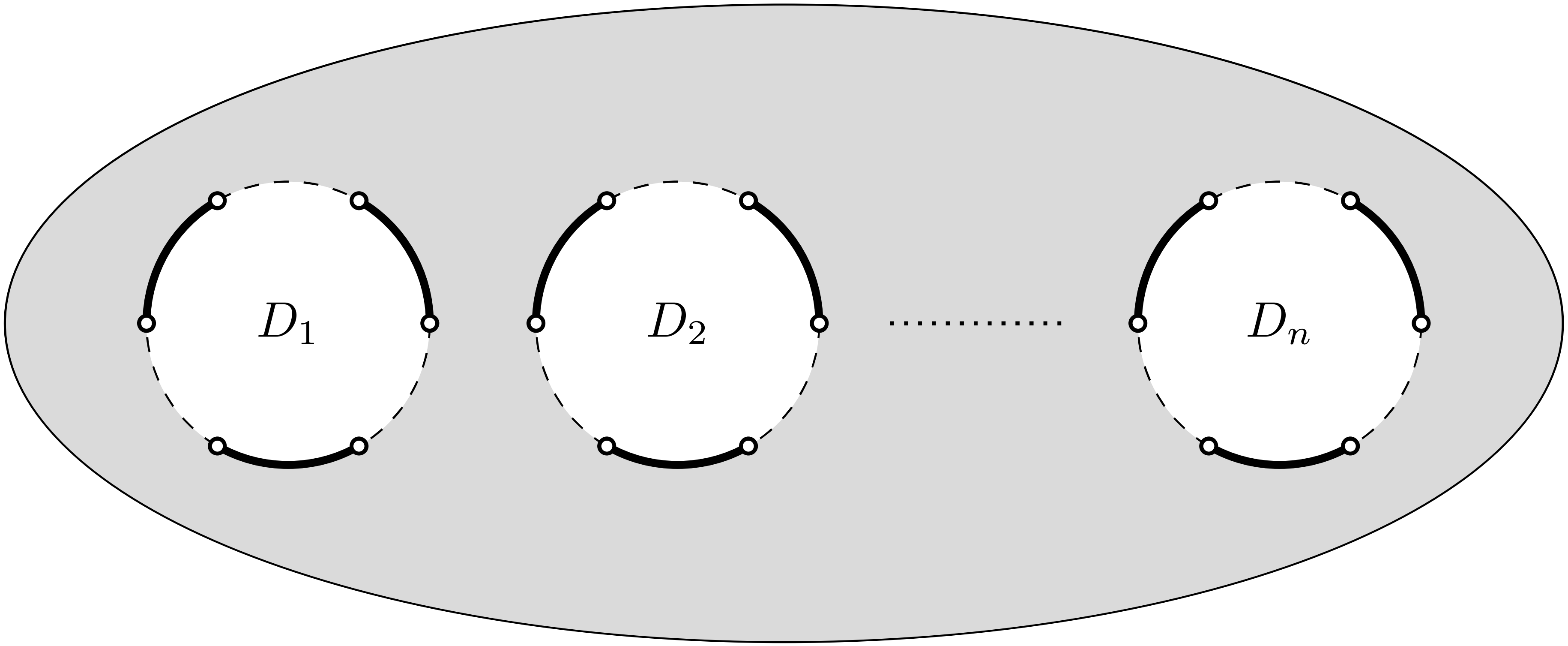
Representation = To represent the group as an algebra of **matrices**

Then the study of the framed group becomes a problem of the **linear algebra**.

Homological representation

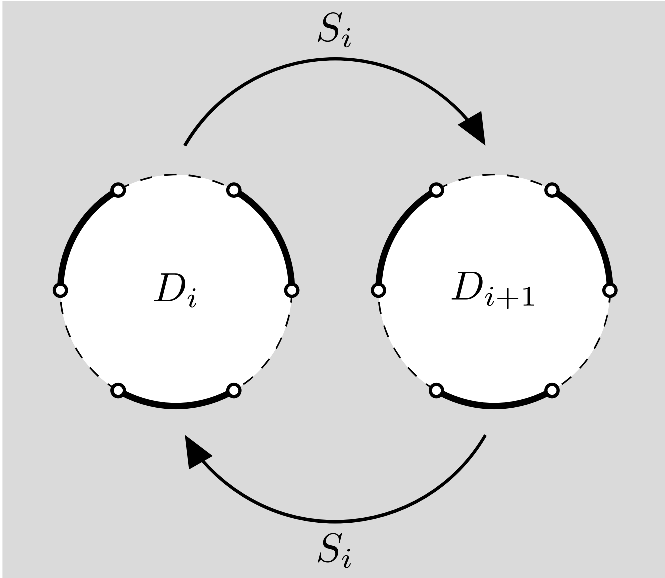
Theorem

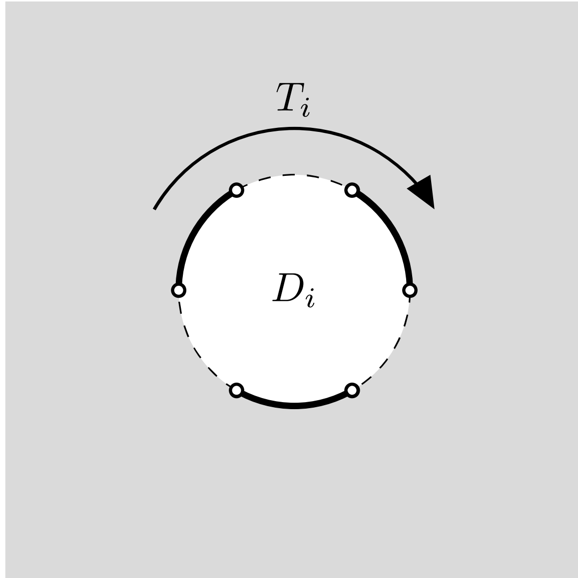
There are representations of the framed braid group constructed from the geometry (homology group) of the following surface.



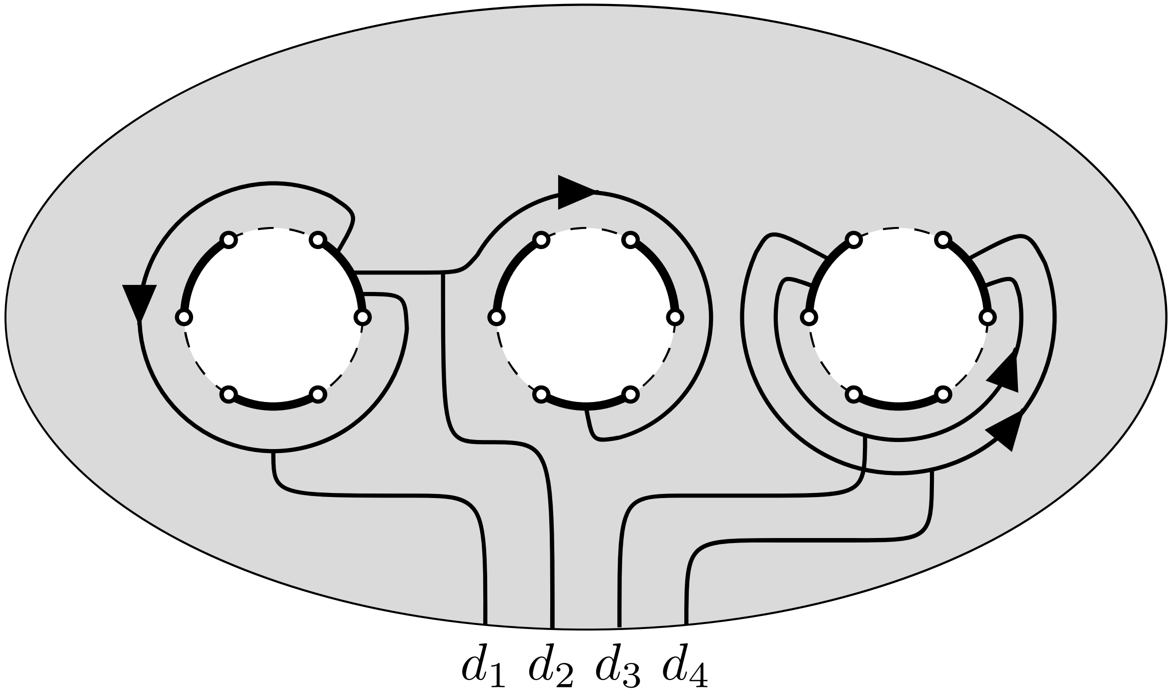
Graphical description

Matrices





Vectors



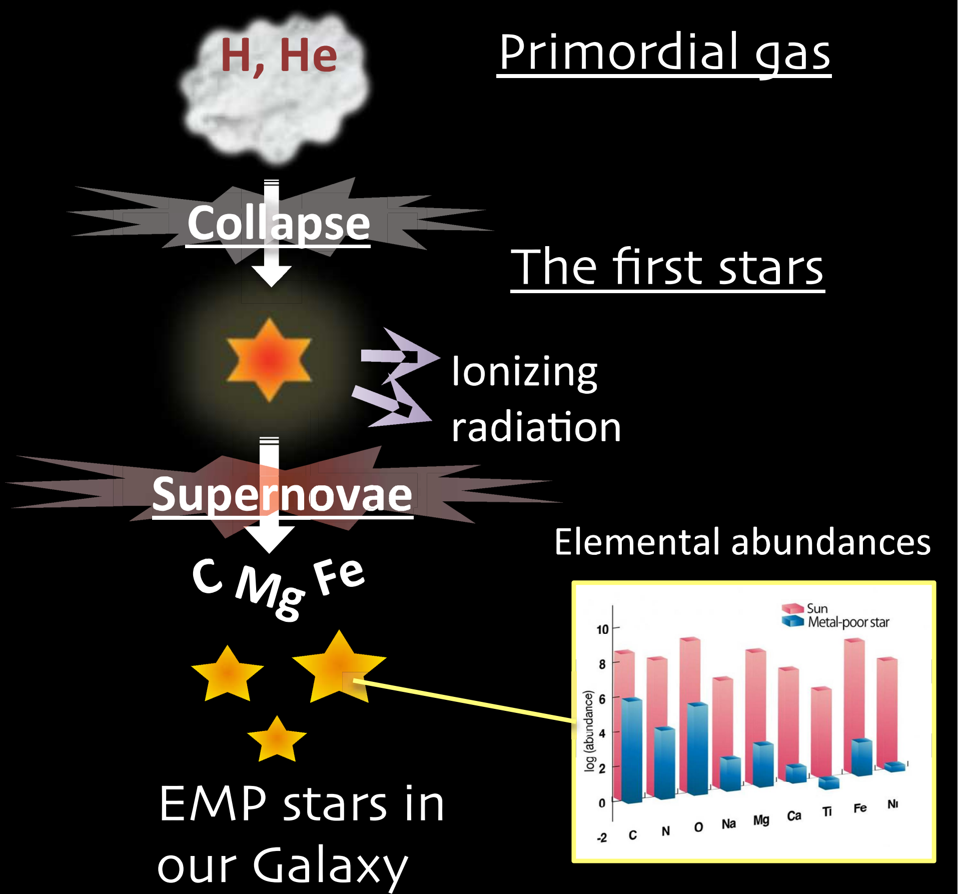
Thank you for your attention.

Nature of the first stars in the universe probed by metal-poor stars in the Milky Way

Ishigaki, M. N.[1], Tominaga, N.[1,2], Kobayashi, C.[1,3], and Nomoto, K.[1]
[1]. Kavli IPMU, [2]. Konan University, [3]. University of Hertfordshire

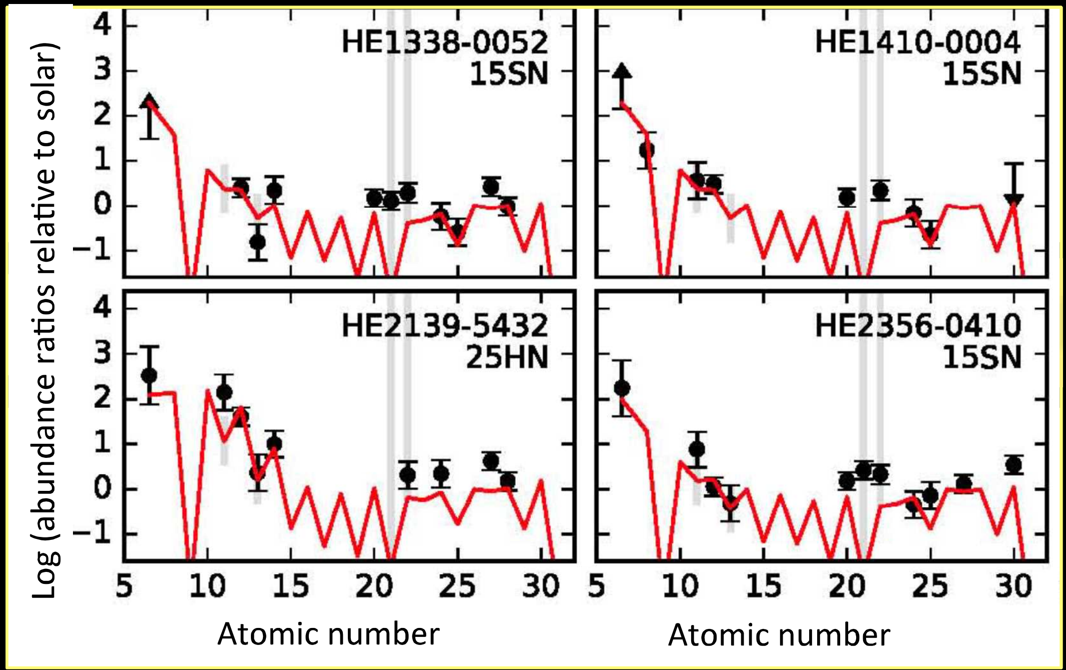
We calculate supernova yields of the first stars that best reproduce observed abundance patterns of metal-poor stars to obtain inference on **<u>the typical mass of the first stars</u>**

- Our model
  - Hydrostatic and explosive nucleosynthesis in the first stars with M=13, 15, 25, 40 and 100$M_{\odot}$
  - An extensive grid of parameters to describe the mixing and fallback in aspherical supernovae
- The data
  - Precise elemental abundances from carbon to zinc in > 200 extremely metal-poor stars from literature

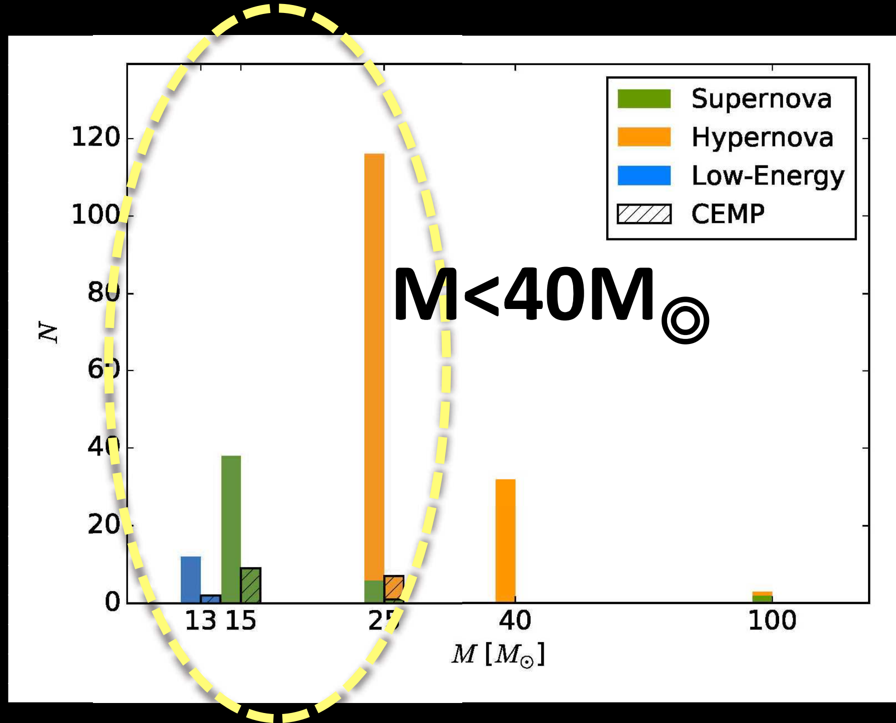


Implications for the masses of the first stars

Observed vs model abundance patterns



The histogram for the first star's masses



Elemental abundances of more than 90% of the EMP stars in our sample are **best explained by the first stars with M<40M◎, which leave behind a black hole with a few M◎**

Geography of algebraic varieties

Chen Jiang

Kavli IPMU, Univerisity of Tokyo

October 17, 2017

Goal

One of the main goals of algebraic geometry is to classify algebraic varieties.

Method

To study invariants.

What is Geography?

The study of the relations between invariants.

What invariants are we interested in?

We are working on *birational geometry*, i.e., to study algebraic varieties under birational equivalence. So we are interested in birational invariants, in particular, for a projective smooth variety X of dimension n, we are interested in the following two birational invariants.

- *Geometric genus*

$$p_g(X) := h^0(X, \omega_X),$$

- *Canonical volume*

$$\mathrm{vol}(X) := \lim_{m\to\infty} \frac{h^0(X, \omega_X^{\otimes m})}{m^n/n!}$$

In particular, we are interested in projective smooth varieties *of general type* (i.e. $\mathrm{vol}(X) > 0$).

$\dim X \leq 2$

$\dim X = 1$

$$\mathrm{vol}(X) = \deg K_X = 2p_g(X) - 2.$$

$\dim X = 2$

Miyaoka–Yau inequality:

$$\mathrm{vol}(X) \leq 9(p_g(X) + 1).$$

Noether inequality:

$$\mathrm{vol}(X) \geq 2p_g(X) - 4.$$

Joint with Jungkai Chen and Meng Chen, we showed:

$\dim X = 3$

Noether inequality: If $p_g \geq 27$, then

$$\mathrm{vol}(X) \geq \frac{4}{3} p_g(X) - \frac{14}{3}.$$

Thank you for your attention!

Operator dimensions from moduli

Shunsuke Maeda

Kavli IPMU

October 17$^{\text{th}}$, 2017

Based on:
S. Hellerman, SM, and M. Watanabe, [arXiv:1706.05743]
S. Hellerman and SM, [arXiv:1710.07336]

Introduction

- I am studying quantum field theories with conformal symmetry and supersymmetry (superconformal field theories).
- It is often the case that they are strongly coupled and perturbative calculations are useless.
- So it is important to find a way of computing physical observables in such theories.

Effective field theory at large charge

- It was shown in Hellerman, Orlando, Reffert, and Watanabe [2015] that in a conformal field theory with global symmetry, the **sector of large global charge** can be studied perturbatively by an effective field theory on a spatial 2-sphere.
- Especially in superconformal field theories with Ricci-flat moduli space of vacua, we predict that the sector of large R-charge is described by a **free field theory**, with corrections suppressed by the inverse of R-charge. Hellerman, SM, and Watanabe [2017]

Operator dimensions

- From the effective field theory at large charge density, we can make a number of predictions for physical observables in the sector of large charge.

- As a concrete example, let us take a 3d superconformal fixed point obtained by starting with three free chiral superfields X, Y, Z, and giving them a superpotential $W = XYZ$.

- In this theory, we predict that the dimension of the third-lowest operator of a given large $\mathrm{U}(1)_{\mathrm{R}}$ charge J ($\gg 1$) is

$$\Delta = J + 2 - \frac{\kappa}{J^3} + O(J^{-4}).$$

- We do not know how to compute the constant κ, but can show that a negative κ would be inconsistent with **unitarity**,
so κ has to be **nonnegative**.
Adams, Arkani-Hamed, Dubovsky, Nicolis, and Rattazzi [2006]

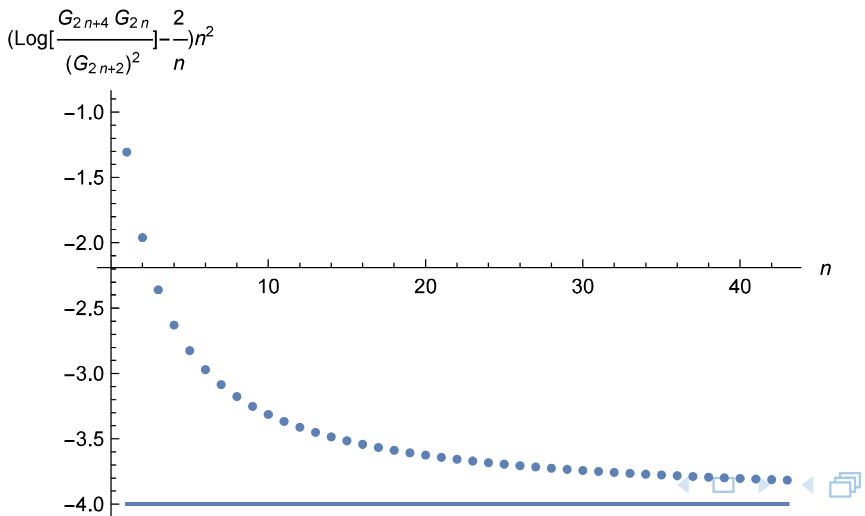
Two-point functions

- If time permits let me present another prediction which is about correlation functions and the a-coefficient of conformal anomaly.
- In 4d $\mathcal{N}=2$ SU(2) SQCD with four flavors, we predict

$$\lim_{n\to\infty}\left(n\log\left[\frac{\langle\phi^{n+2}(x)\bar{\phi}^{n+2}(0)\rangle\langle\phi^{n}(x)\bar{\phi}^{n}(0)\rangle}{\left[\langle\phi^{n+1}(x)\bar{\phi}^{n+1}(0)\rangle\right]^2}\right]-2n\right)$$

$$=-2a_{\mathrm{SQCD}}-\frac{25}{12}=-4,$$

and the exact computation seems to agree with this:
for instance, at the self-dual point $\tau=i$ Hellerman and SM [2017]



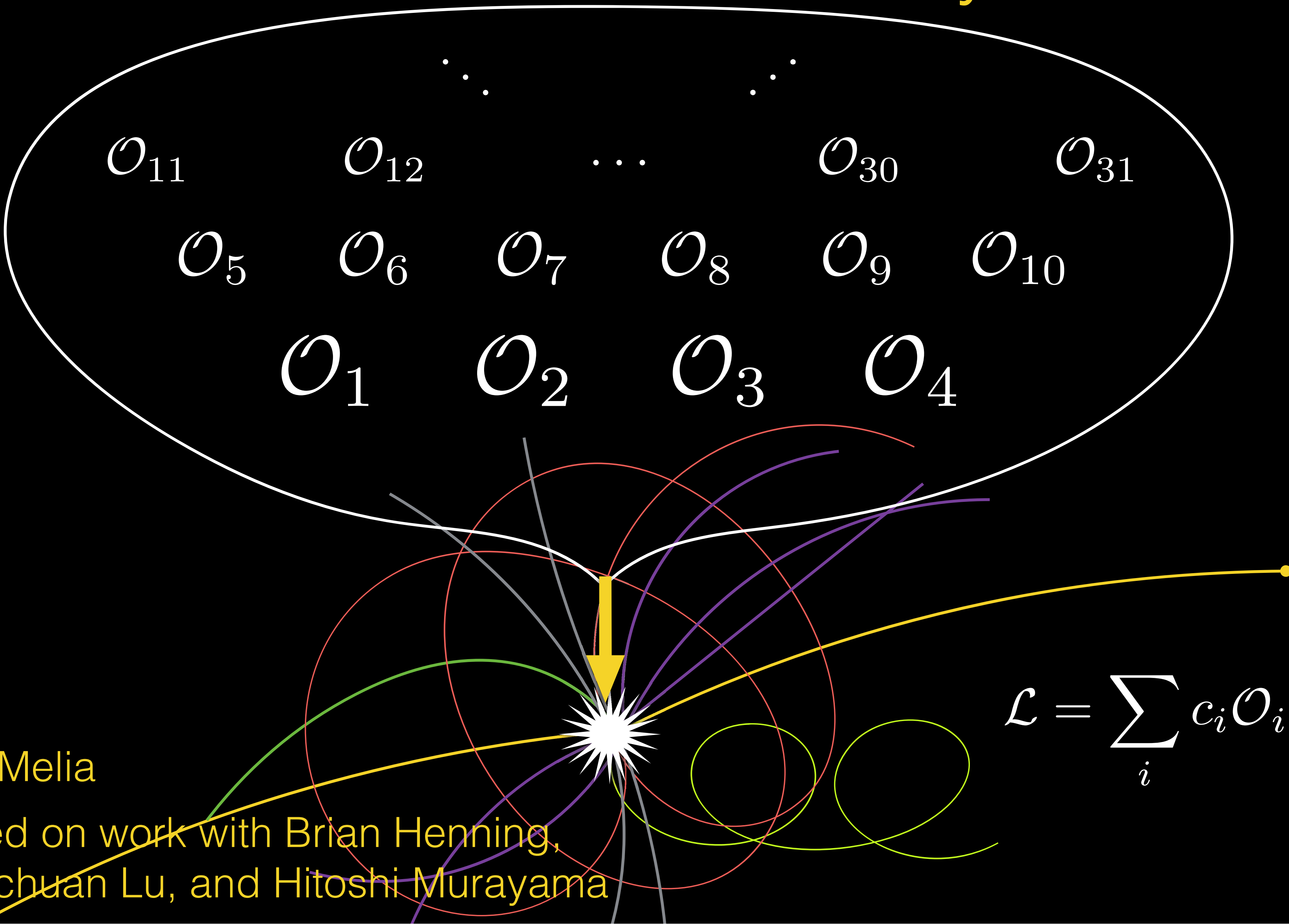
A. Adams, N. Arkani-Hamed, S. Dubovsky, A. Nicolis, and R. Rattazzi. Causality, analyticity and an IR obstruction to UV completion. *JHEP*, 10:014, 2006. doi: 10.1088/1126-6708/2006/10/014.

S. Hellerman and SM. On the Large *R*-charge Expansion in $\mathcal{N} = 2$ Superconformal Field Theories. 2017.

S. Hellerman, D. Orlando, S. Reffert, and M. Watanabe. On the CFT Operator Spectrum at Large Global Charge. *JHEP*, 12:071, 2015. doi: 10.1007/JHEP12(2015)071.

S. Hellerman, SM, and M. Watanabe. Operator Dimensions from Moduli. *JHEP*, 10:89, 2017. ISSN 1029-8479. doi: 10.1007/JHEP10(2017)089.

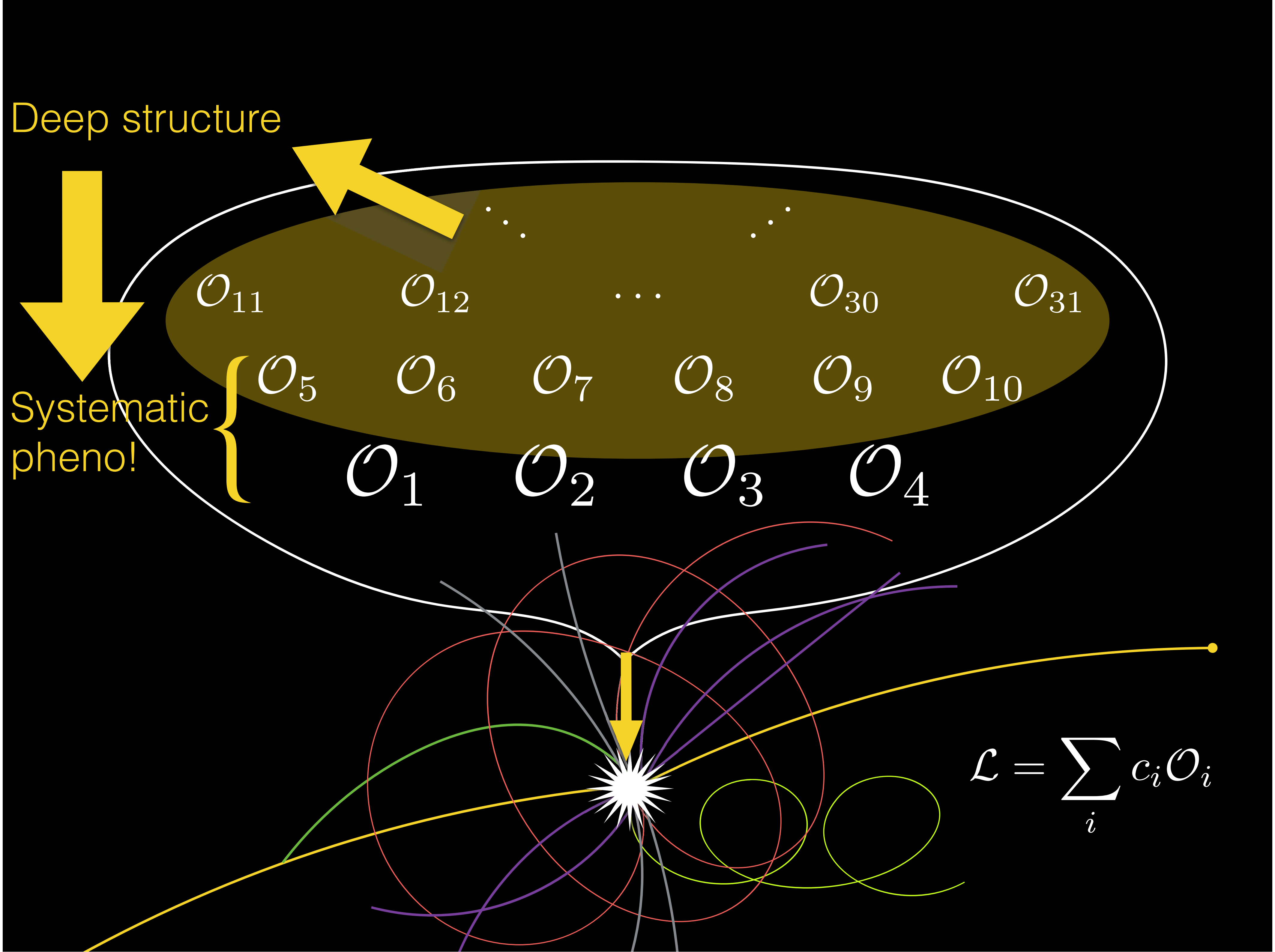
Understanding the deep structure of effective field theory



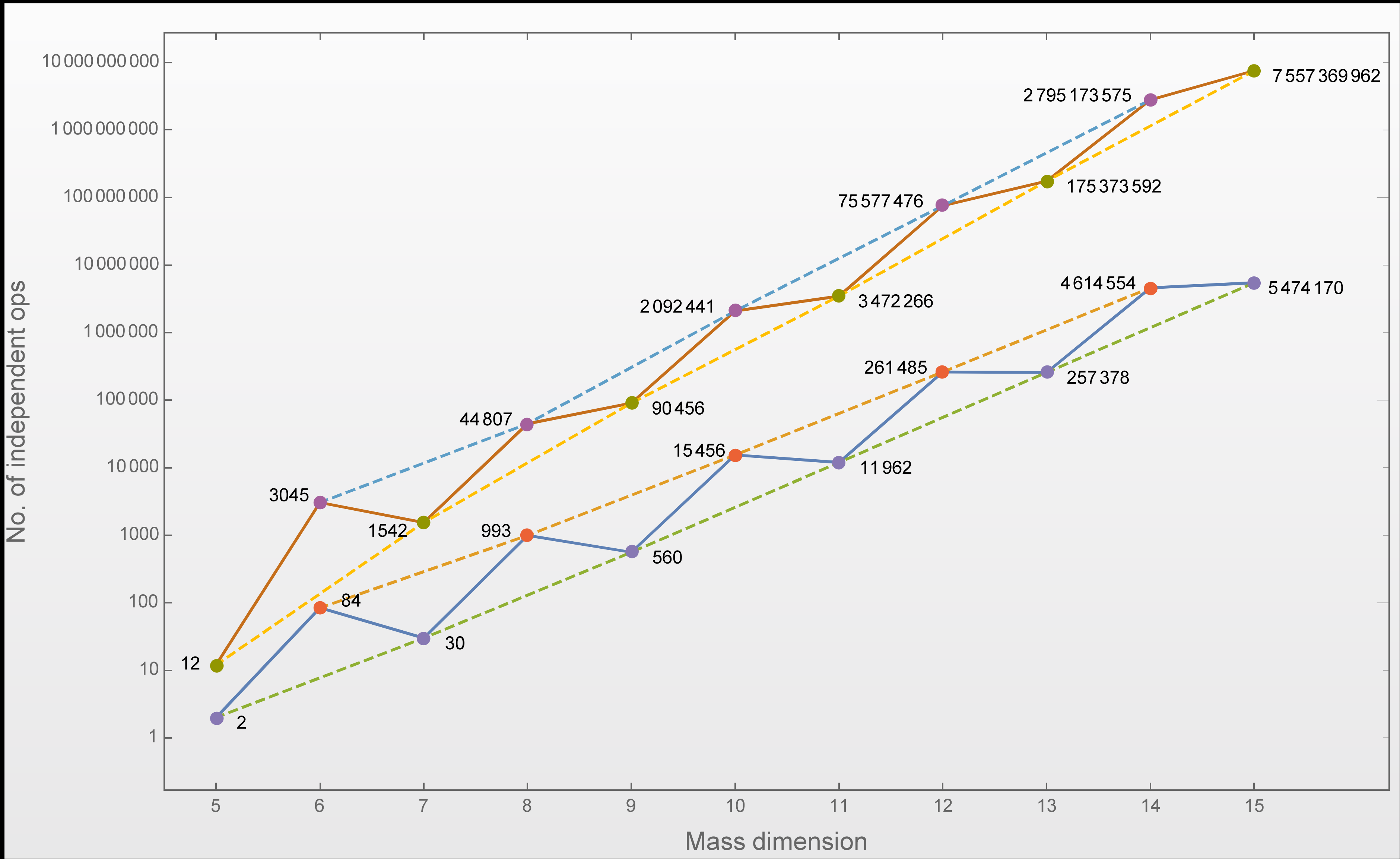
$$\mathcal{L} = \sum_i c_i \mathcal{O}_i$$

Tom Melia

based on work with Brian Henning, Xiaochuan Lu, and Hitoshi Murayama



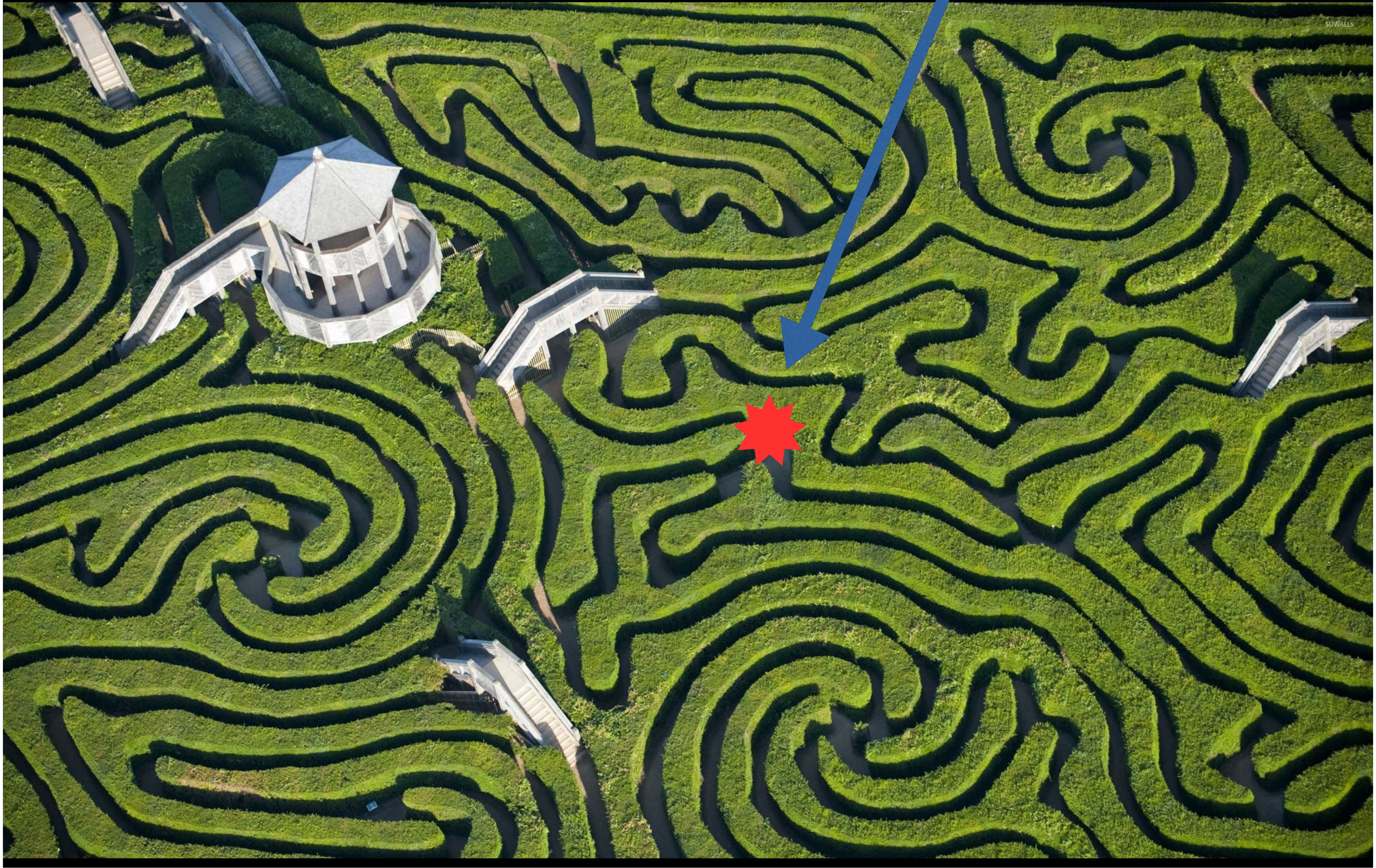
Deep structure
Systematic pheno!
$\mathcal{O}_{11}$ $\mathcal{O}_{12}$ $\cdots$ $\mathcal{O}_{30}$ $\mathcal{O}_{31}$
$\mathcal{O}_5$ $\mathcal{O}_6$ $\mathcal{O}_7$ $\mathcal{O}_8$ $\mathcal{O}_9$ $\mathcal{O}_{10}$
$\mathcal{O}_1$ $\mathcal{O}_2$ $\mathcal{O}_3$ $\mathcal{O}_4$
$\mathcal{L} = \sum_i c_i \mathcal{O}_i$

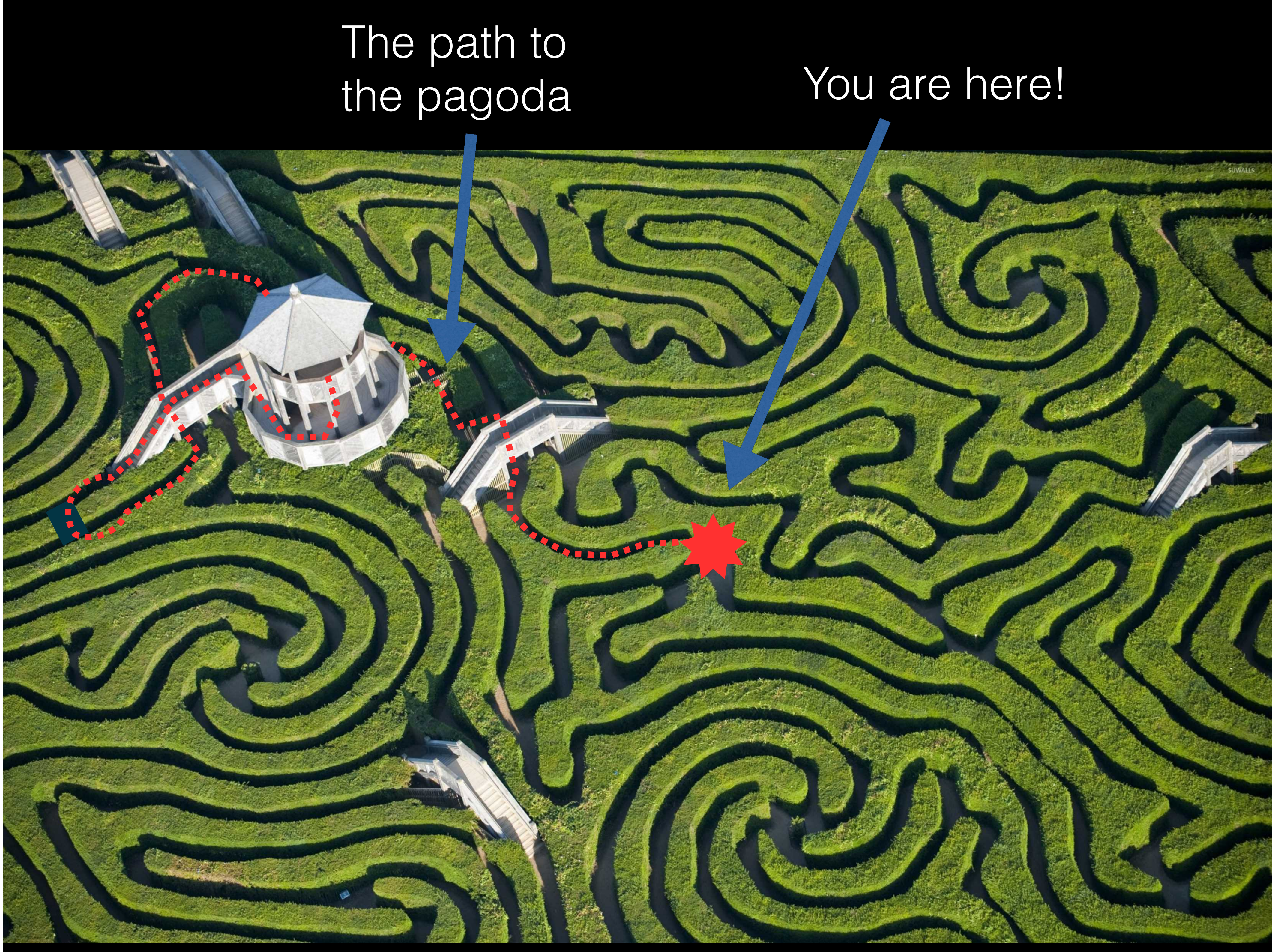


Standard model EFT

We are stuck in a maze:

You are here!




The path to the pagoda
You are here!

Current exploration..

...no obvious signposts so far

What can we understand about the maze in general?

are there any deep underlying patterns?!

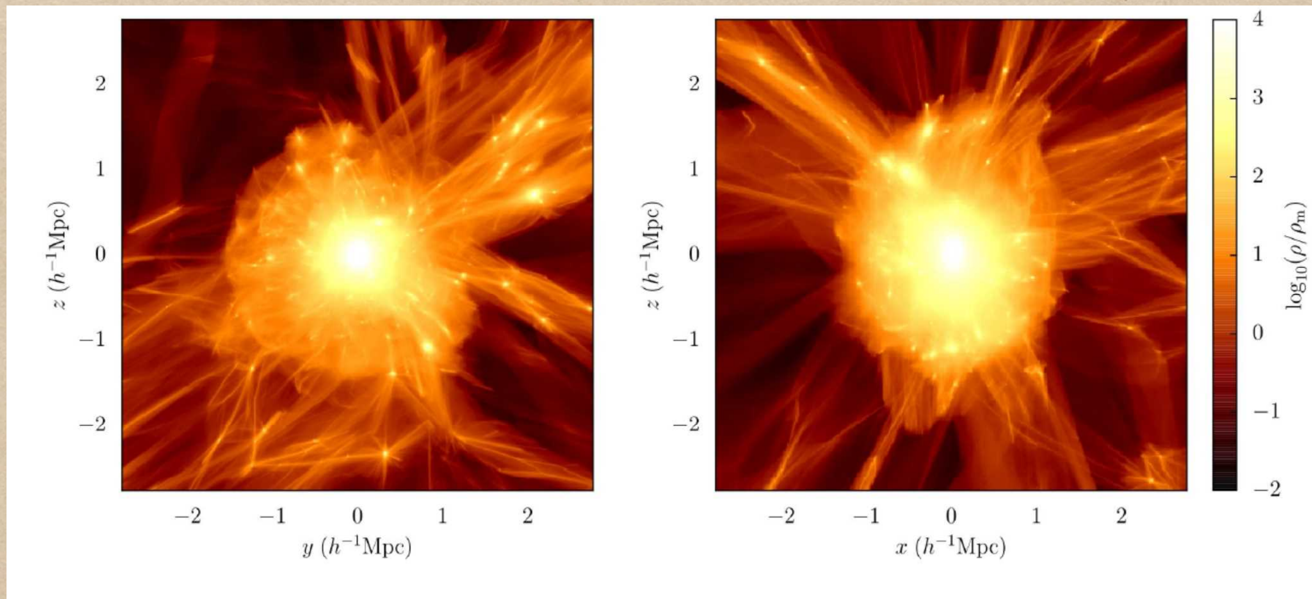
Splashback radius:
the edge of a dark matter halo

Surhud More
Kavli IPMU

Three simple questions

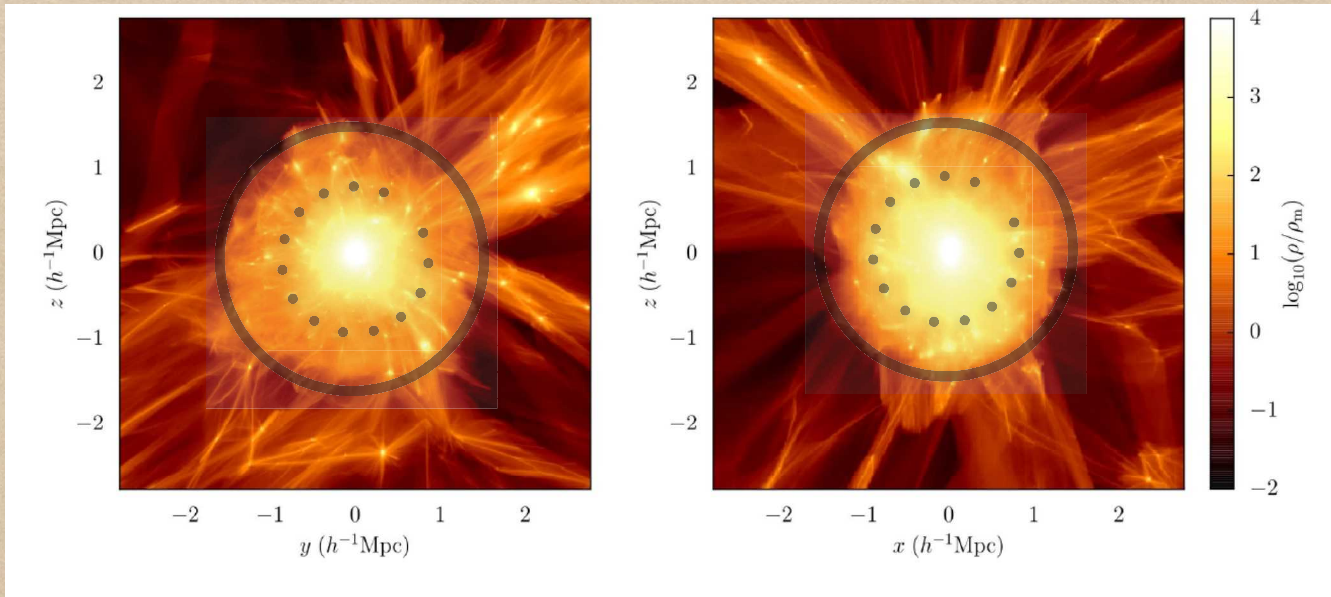
- Do dark matter halos have boundaries? Yes!
- Are these halo boundaries physically interesting? Yes!
- Can these halo boundaries be observed? Yes!

Visual impression



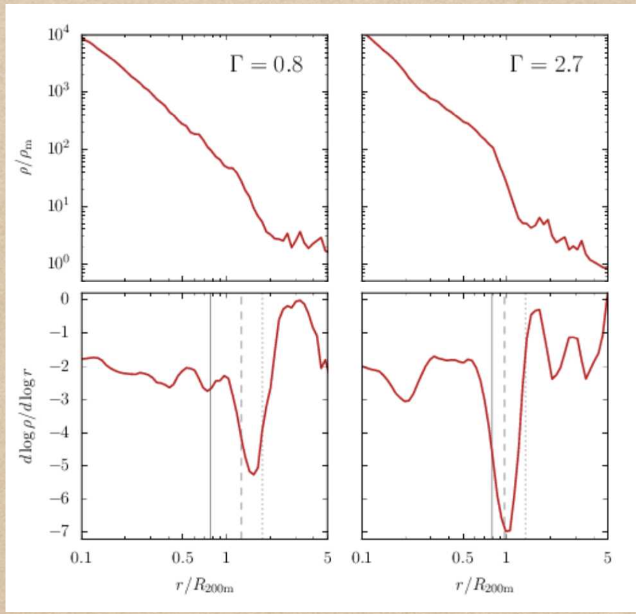
- Where would you assign the halo boundary?
  - Please participate in the poll by using the green stickers.

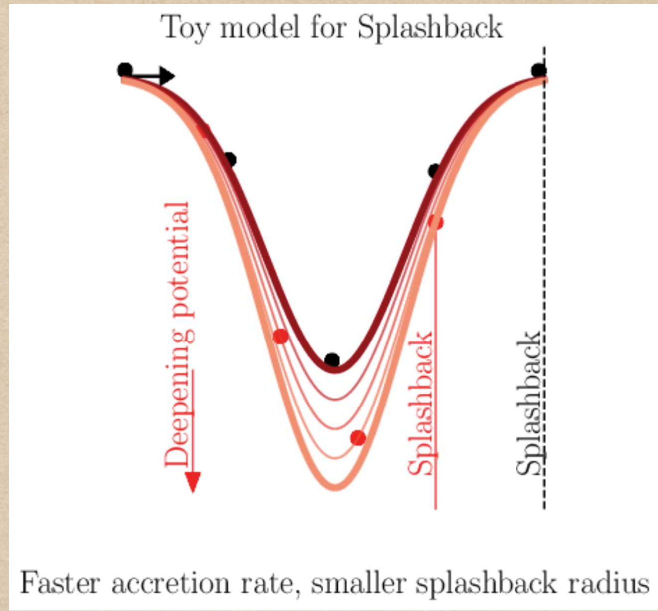
Visual impression



- Where would you assign the halo boundary?
  - Please participate in the poll by using the green stickers.

Physical halo boundary

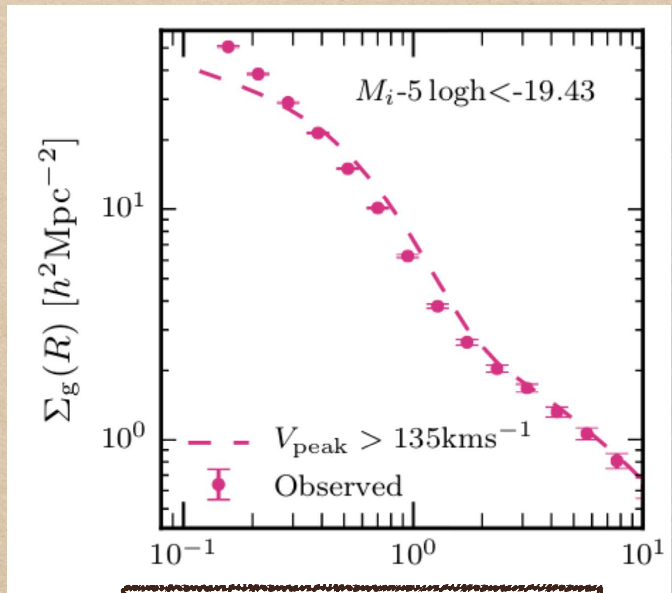




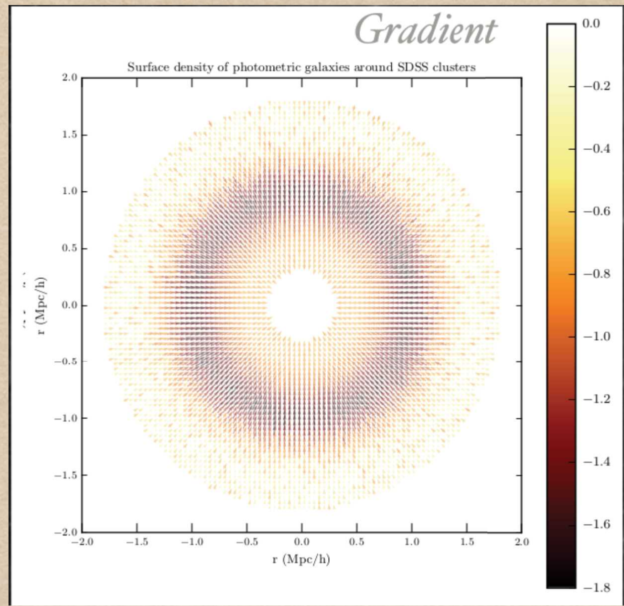
- Why does our eye pick up a halo boundary?
- What is its physical significance?

Participate in yet another quiz!

Observations of halo boundaries



Radius (Mpc/h)



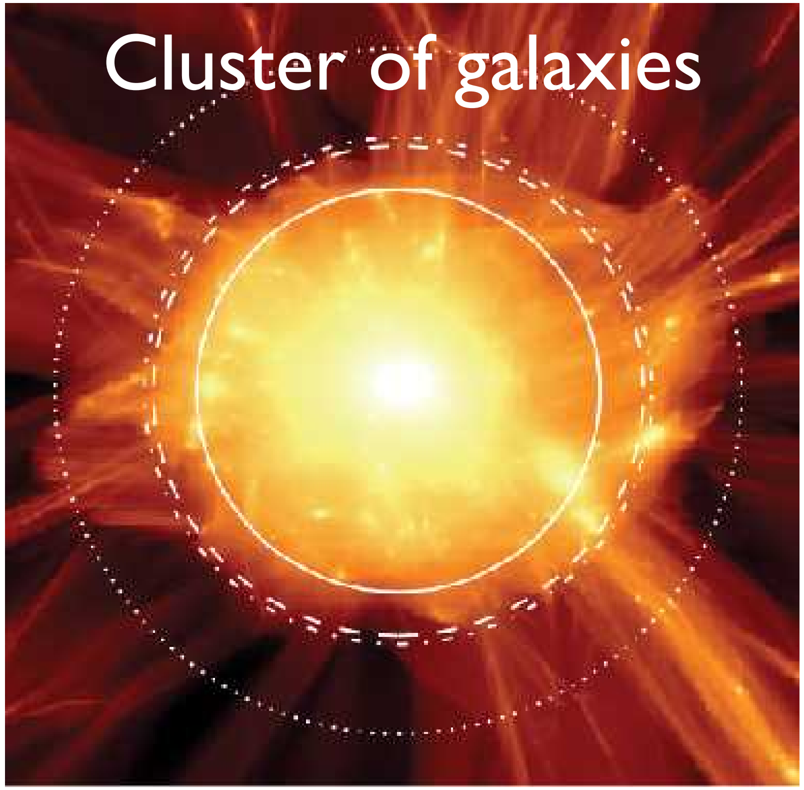
- Sharp density drops in the number density of galaxies around clusters observed
- Are they at the same place where they were expected? And if not, then speculate with me why?

Constraints on the mass-richness relation from the abundance and weak gravitational lensing of Sloan Digital Sky Survey (SDSS) clusters

Ryoma Murata[1,2], Takahiro Nishimichi[1,3], Masahiro Takada[1], Hironao Miyatake[4,1], Masato Shirasaki[5], Surhud More[1], Ryuichi Takahashi[6], and Ken Osato[2]
1. Kavli IPMU 2. Department of Physics, University of Tokyo 3. CREST, JST
4. Jet Propulsion Laboratory, California Institute of Technology 5. National Astronomical Observatory of Japan 6. Hirosaki University

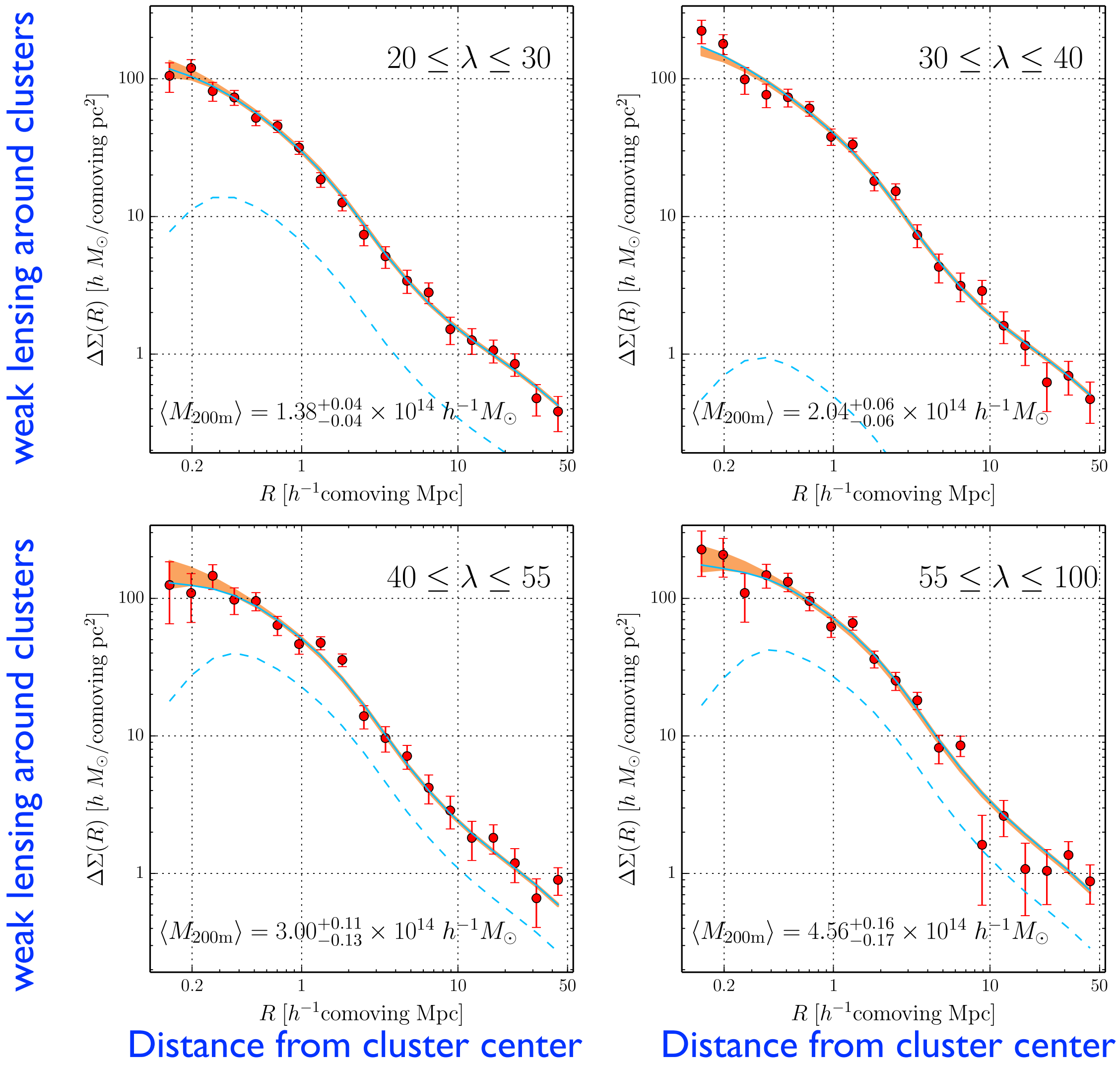
Clusters of galaxies are powerful probes to constrain **cosmology**, including **Dark Matter, Dark Energy, Neutrino mass**.

BUT, we need to calibrate **cluster masses** to *connect* observation with theoretical model (simulations).



More. S et, al.

We develop a new analysis method to calibrate cluster masses, with **theoretical prediction** at the Planck cosmology based on a suite of **N-body simulations**.

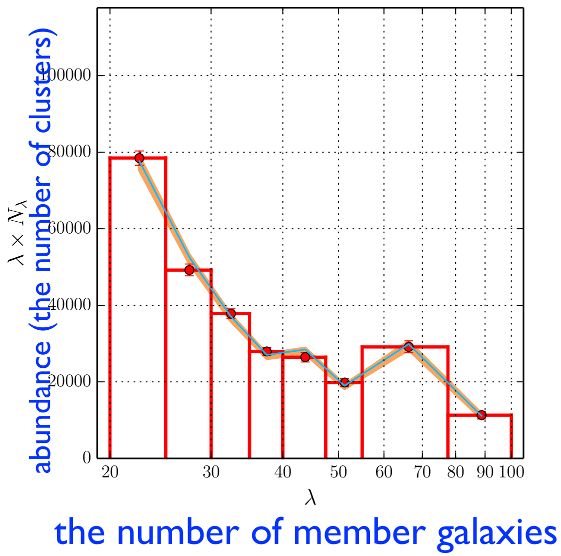


Sloan Digital Sky Survey (SDSS) cluster and lensing data

$\chi^2_{\rm min}/{\rm dof} = 79.5/75$

$\langle M_{200m,\ 20\leq\lambda\leq100} \rangle = 1.91^{+0.05}_{-0.05} \times 10^{14}\ h^{-1}M_\odot$

DATA (red points)
MODEL (orange regions)



We have found the relation between halo mass and the number of member galaxies, consistent with weak gravitational lensing and abundance simultaneously.

Complex dynamics on derived categories of K3 surfaces

Genki Ouchi

My interest

My interest $\supset$ Symmmetry of algebraic varieties

Especially, on K3 surfaces, hyperKähler manifolds.

e.g. X: K3 surface
$\rightsquigarrow X^{[n]}$: Hilbert scheme of n points on X
$\Uparrow$
hyperKähler of dimension $2n$

X: K3 surface

$\rightsquigarrow D(X)$: derived category of X

$\mathrm{Aut}(X) \subset \mathrm{Aut}(D(X))$ or $\mathrm{Aut}(X^{[n]})$

Corresponding finite groups

$M_{23} \subset Co_0$

Mukai — Huybrechts, Mongardi

Main Theorem

$\exists X$: K3 surface with $\mathrm{Aut}(X) = 1$
s.t. $\exists \Phi \in \mathrm{Aut}(D(X))$ with positive categorical entropy
$\rightsquigarrow \phi \in \mathrm{Aut}(M_\sigma(v))$ with positive topological entropy

$M_\sigma(v)$: moduli space of σ-stable objects with Mukai vector v

σ: stability condition on $D(X)$

$v \in H^*(X, \mathbb{Z})$

SK-Gd: Detecting Pre-supernova Neutrinos

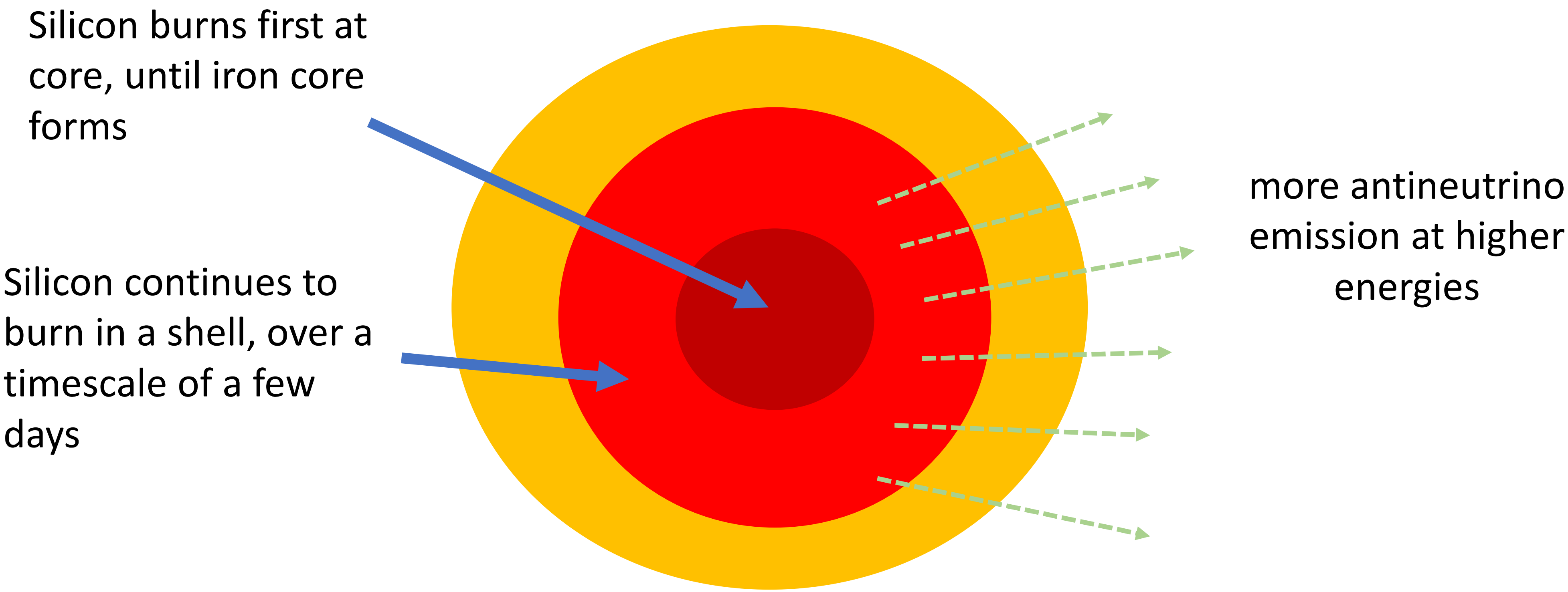
Charles Simpson

charles.simpson@physics.ox.ac.uk

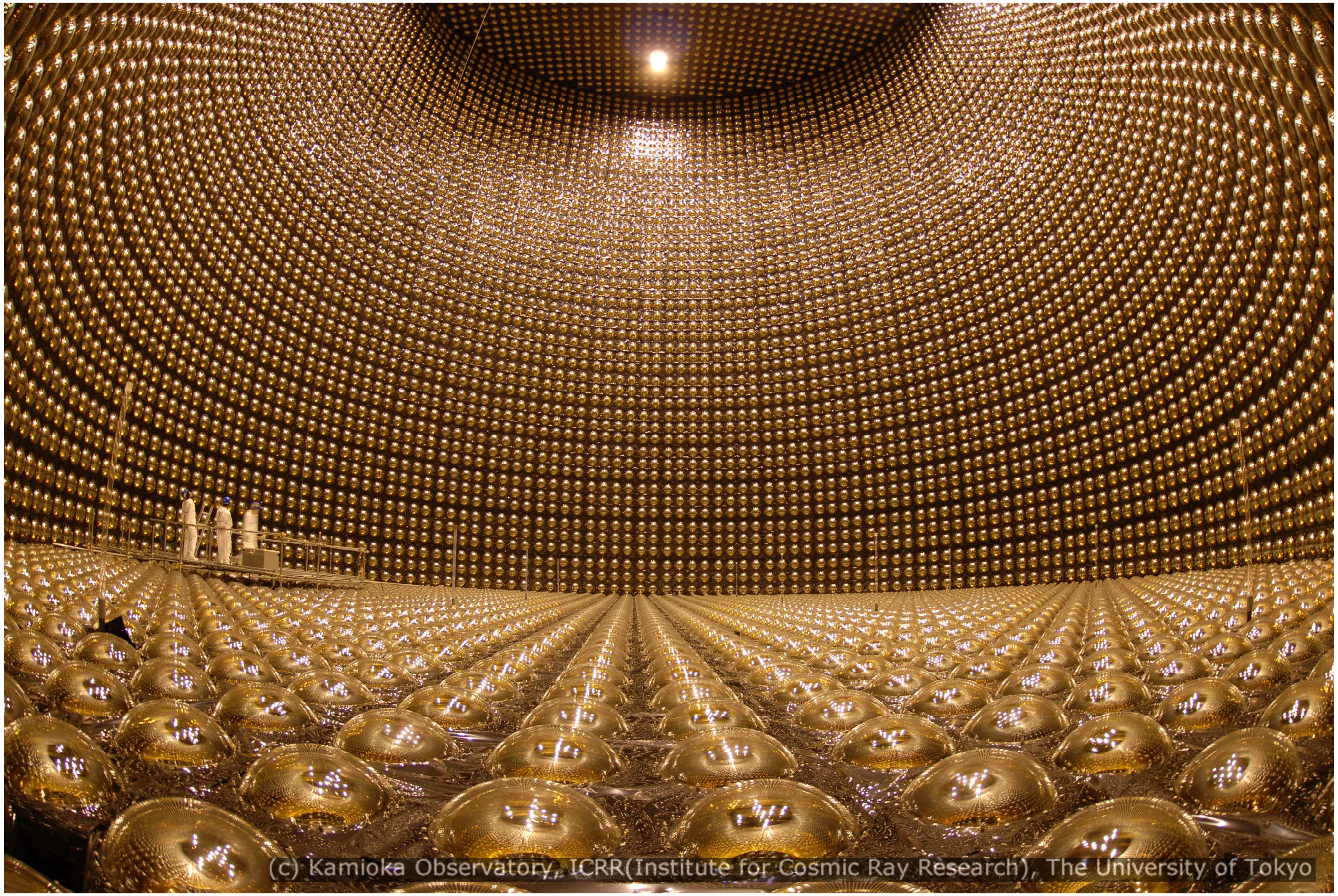
Silicon Burning Basics

A massive star (initial mass >8$M_{\odot}$), at the end of its life contracts and gets hotter…

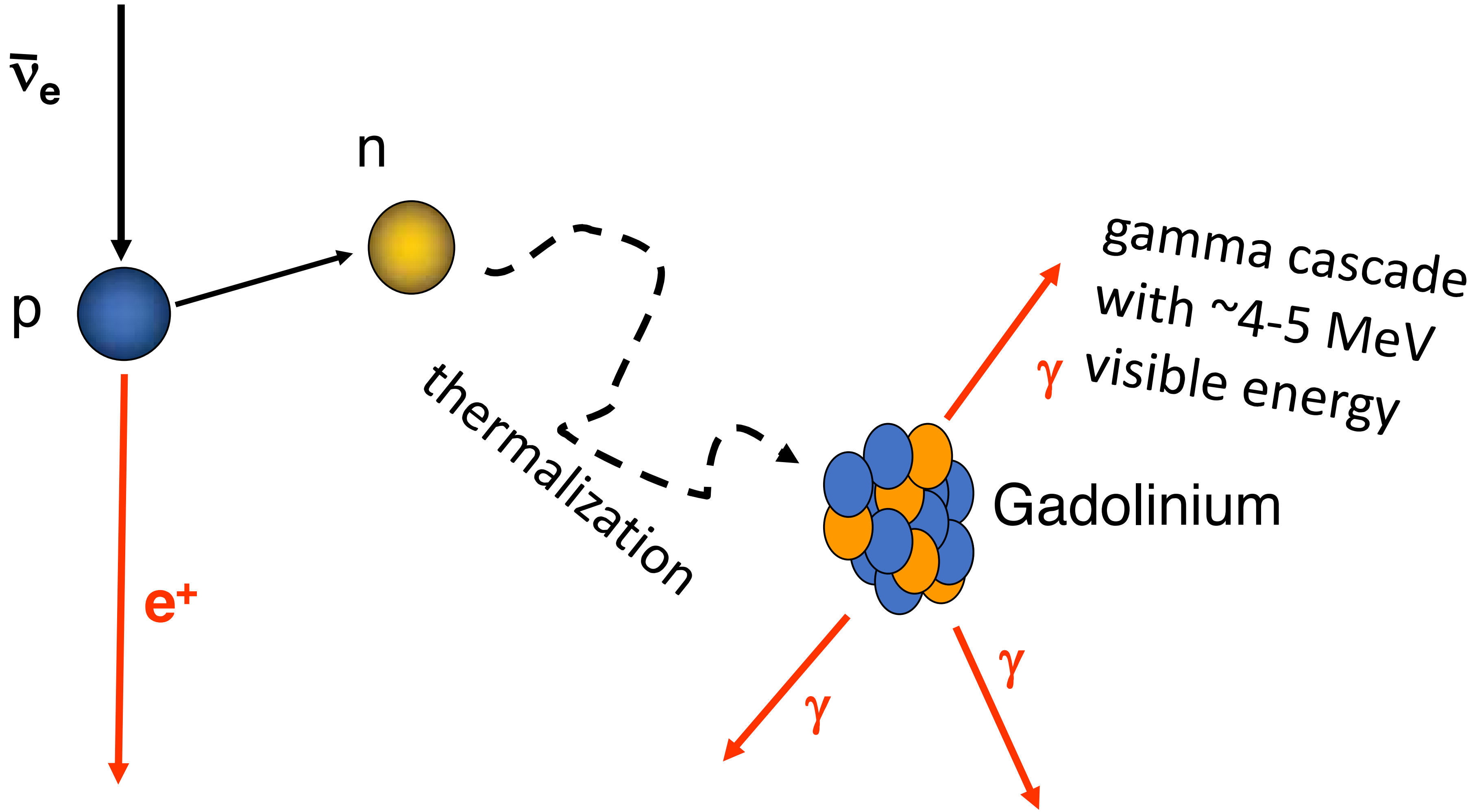
See [Odrzywolek et al. arXiv:astro-ph/0311012v2], and [Yoshida et al. arXiv:1606.04915] for detail



Super Kamiokande with Gadolinium



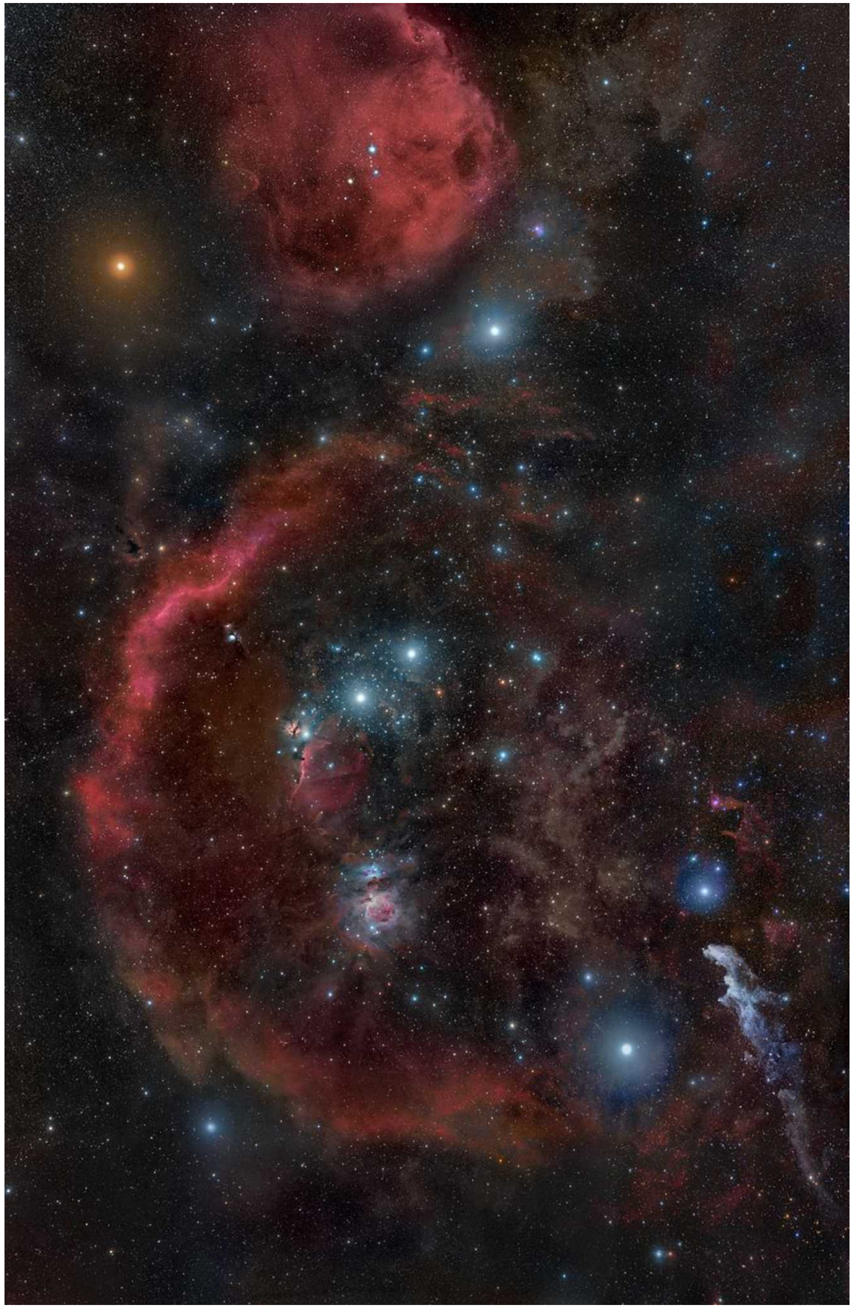
Inverse Beta Decay at SK-Gd



GADZOOKS! Anti-neutrino spectroscopy with large water Cherenkov detectors,
J.F. Beacom and M.R. Vagins, PRL 53, *171101*, 2004

Supernova Neutrinos	Silicon Burning Neutrinos
Energy >10 MeV	Energy <3MeV
Hours before light from SN	Days before light from SN
Detected in 1987	Never detected before
1000s of events in seconds at SK at >10kpc	100s of events in a day at SK-Gd for stars at <1kpc

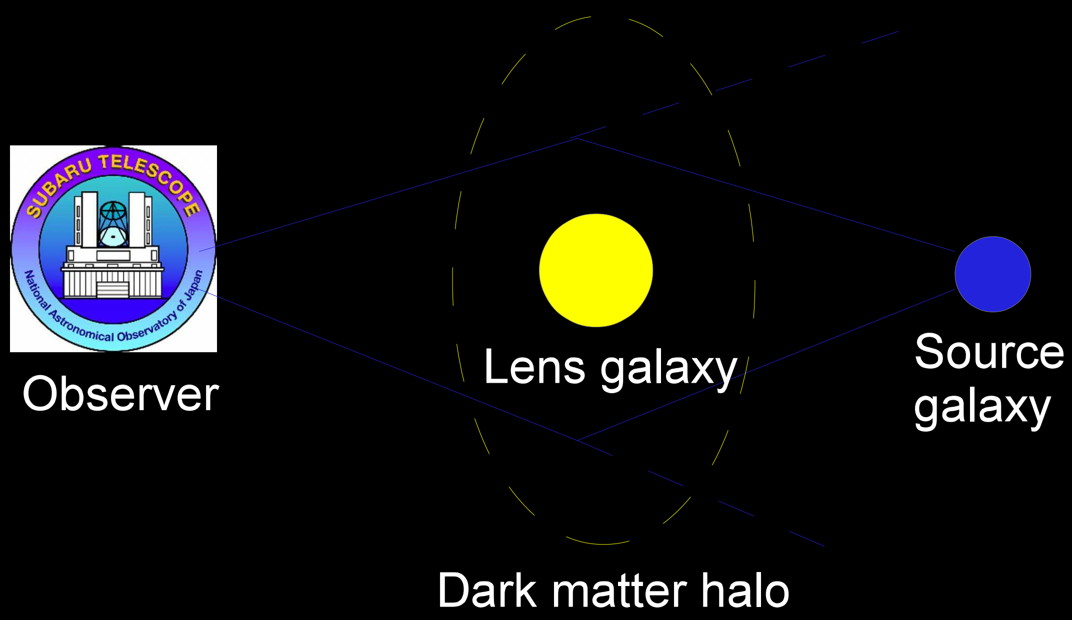
We could see pre supernova silicon burning in a nearby star like Betelgeuse



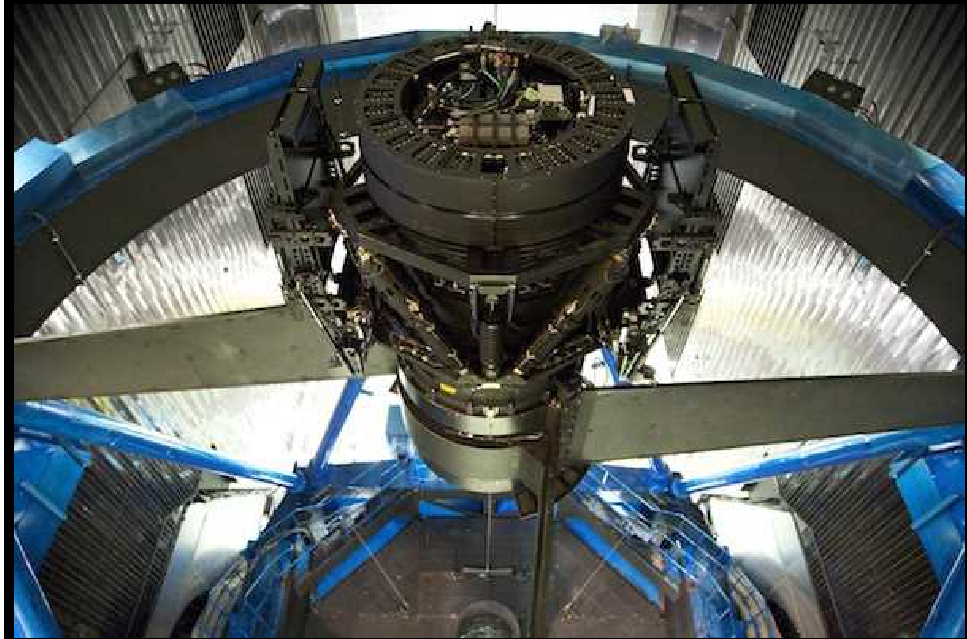
Rogelio Bernal Andreo

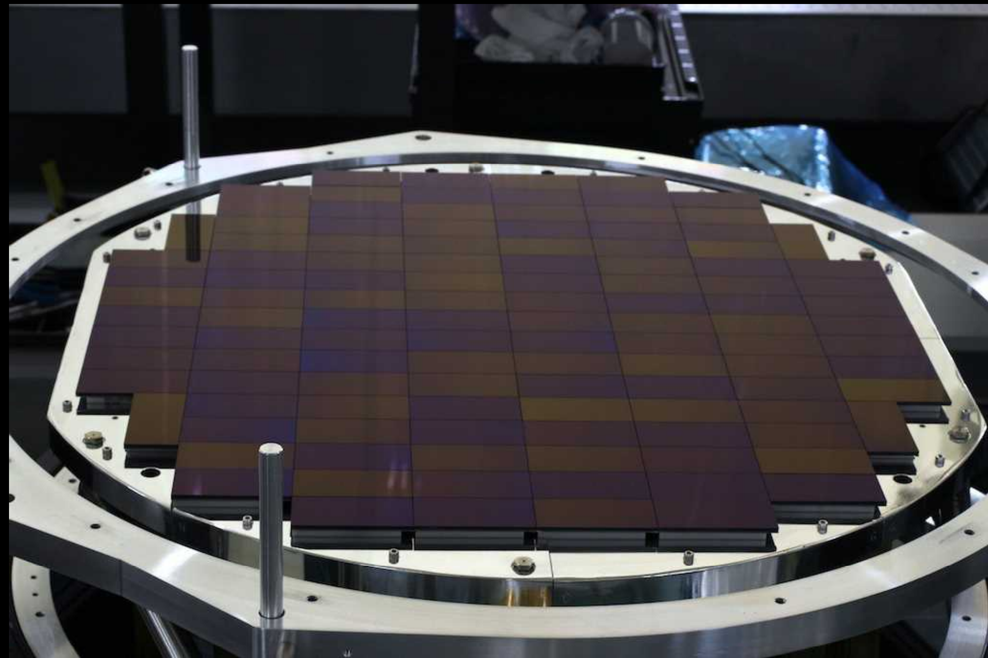
Survey of Gravitationally-lensed Objects in HSC Imaging: SuGOHI

Alessandro Sonnenfeld, James Chan, Yiping Shu, Anupreeta More, Masamune Oguri, Sherry Suyu, Kenneth Wong, et al.



Subaru Hyper Suprime-Cam





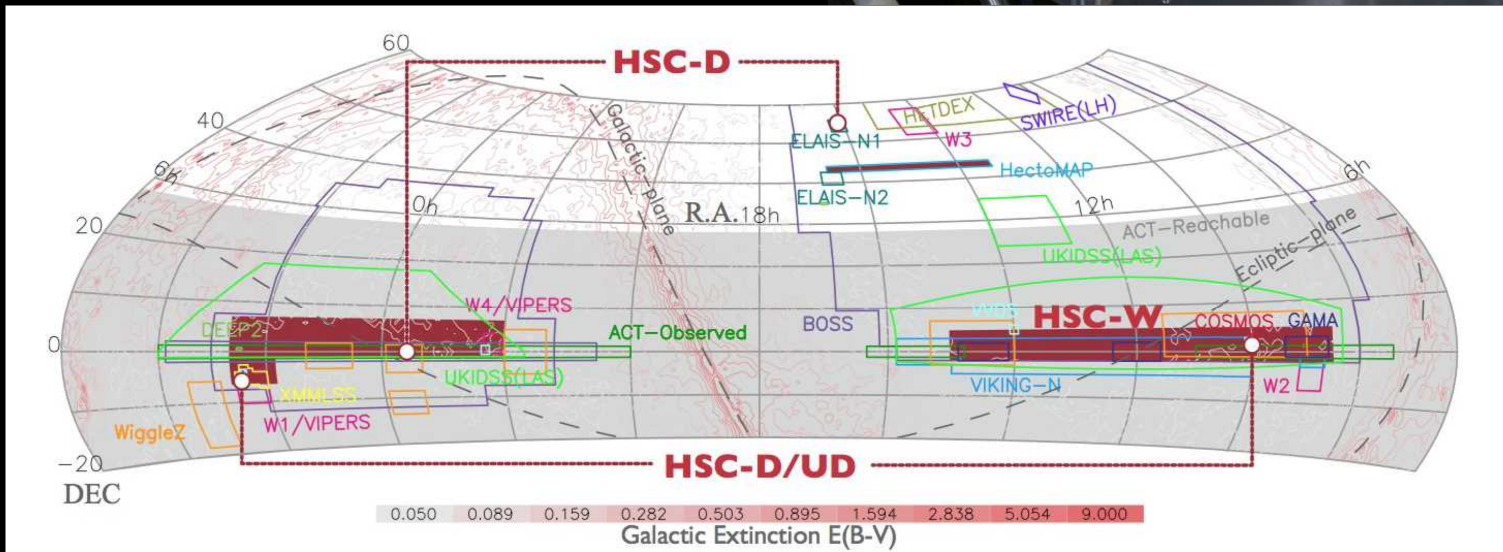


Figure 11: The location of the HSC-Wide, Deep (D) and Ultradeep (UD) fields on the sky in equatorial coordinates. A variety of external data sets and the Galactic dust extinction are also shown. The shaded region is the region accessible from the CMB polarization experiment, ACTPol, in Chile.

YattaLens

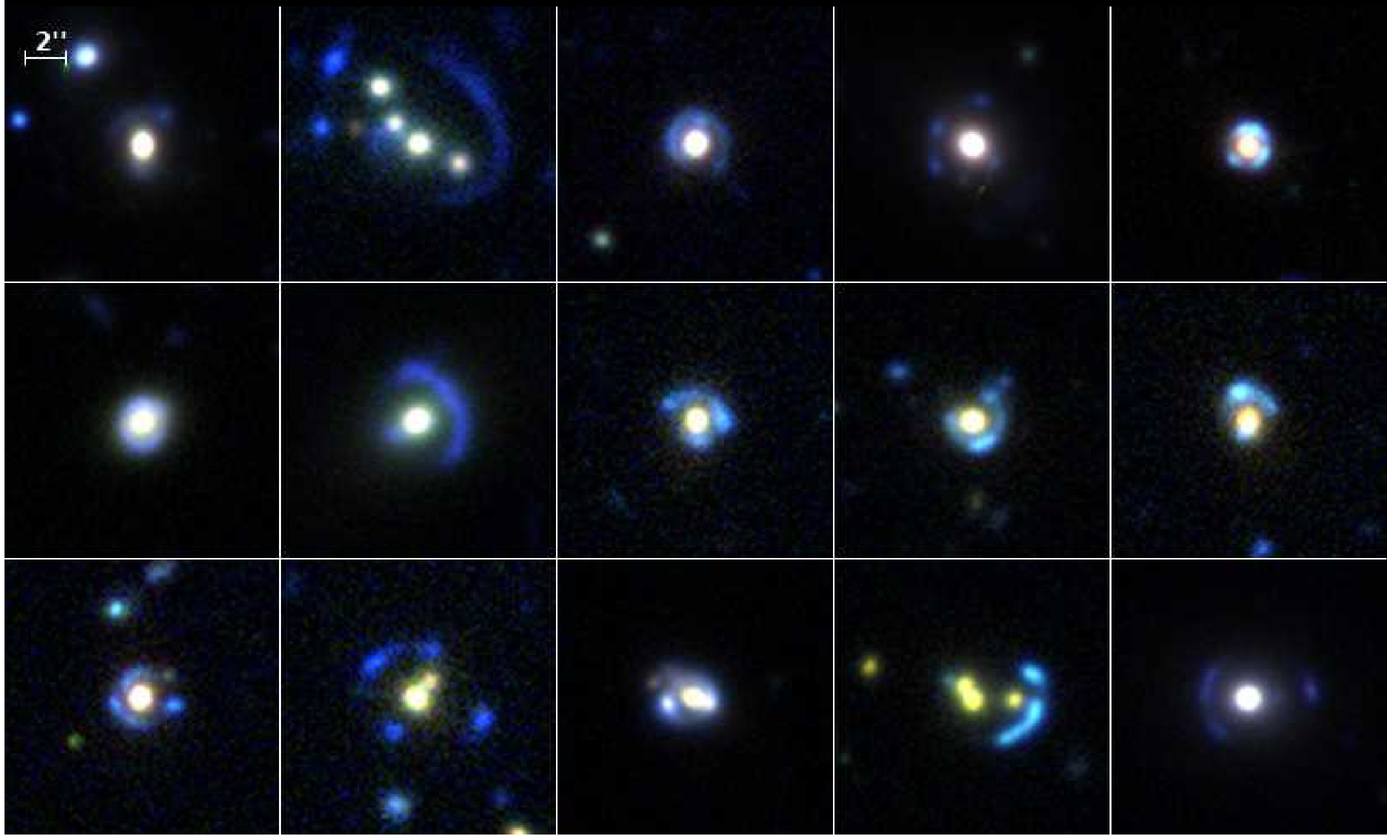


Table 1. Lens candidate statistics.

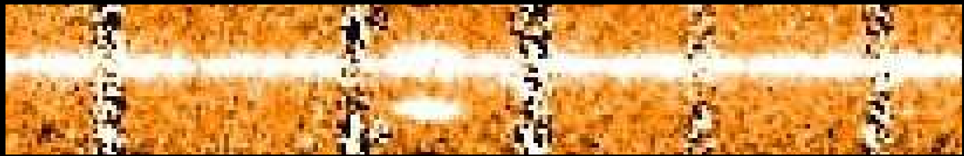
	YattaLens	Chitah	Emission line	Total
Candidates	1480	819	233	2411
Grade A	15	8	3	15
Grade B	31	10	3	36
Grade C	217	39	49	282
Known	10	2	0	10

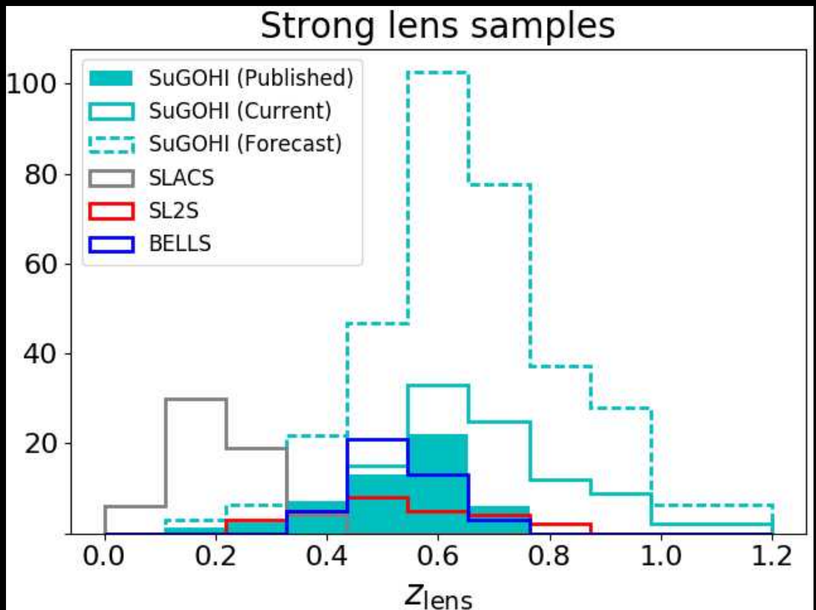
Number of lens candidates found by each search method. The first row lists the number of candidates that have been visually inspected. The second to fourth row list the number of grade A, B and C lenses respectively. The fifth row lists the number of previously known lenses that have been recovered.

15 Grade A lenses

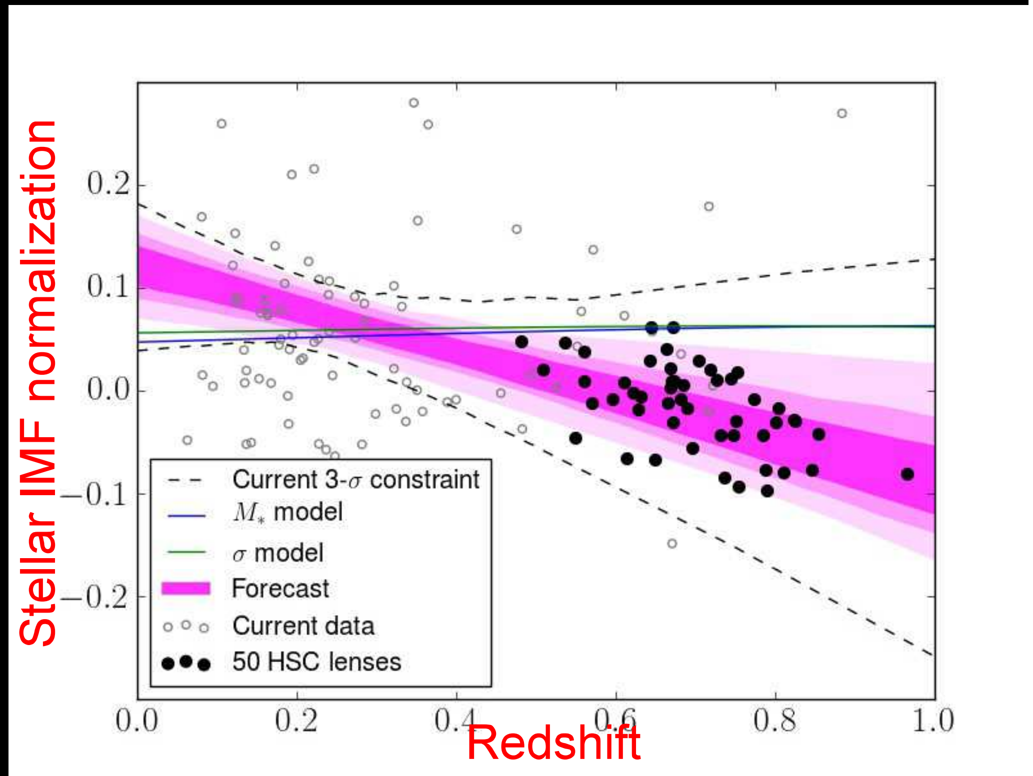
Current work and future plans

Spectroscopic follow-up (X-Shooter)





Science goal: constrain evolution of early-type galaxies to z=0.8



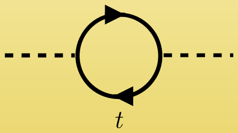
New physics searches in top sector at LHC

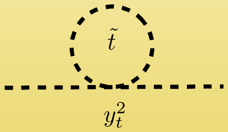
Michihisa Takeuchi (Kavli IPMU)

Motivation

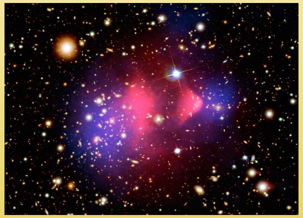
2 big problems in particle physics

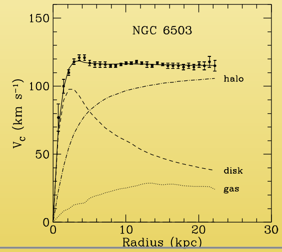
hierarchy problem

$\delta m_h^2 \sim$  $\sim -\frac{3}{4\pi} y_t^2 \Lambda_{\rm SM}^2$

 $\sim +\frac{3}{4\pi} y_t^2 \Lambda^2$

dark matter





New particles at TeV

LHC : TeV collider – best place for TeV new physics searches

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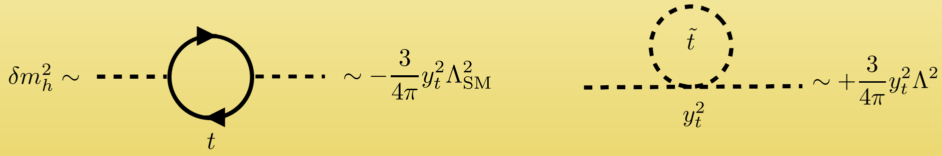
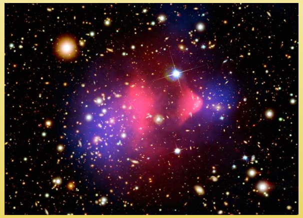
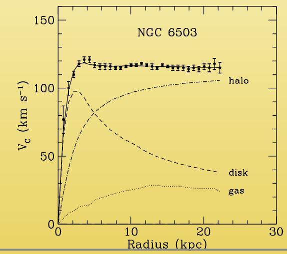


dark matter





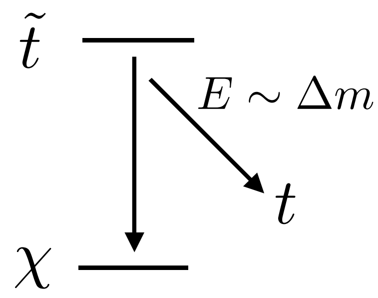
New particles at TeV

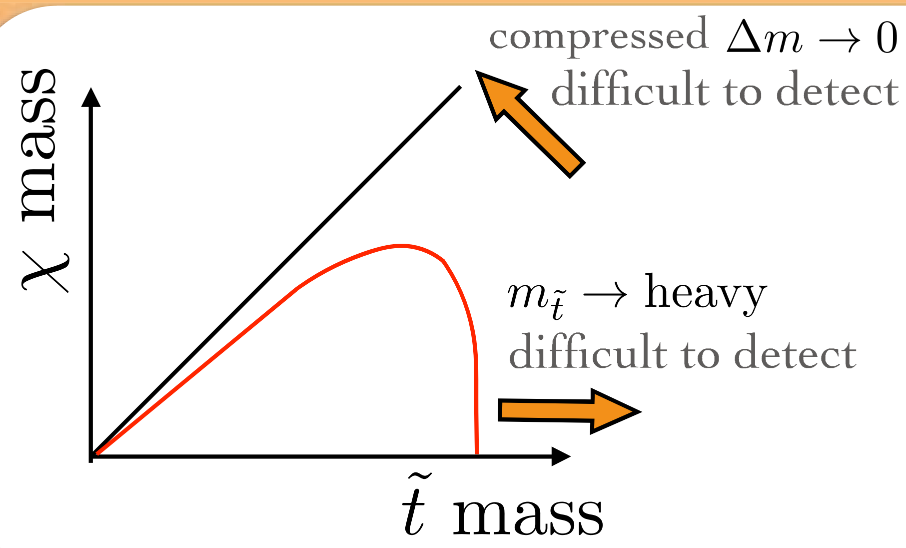
LHC : TeV collider — best place for TeV new physics searches

Scalar top searches at LHC

conventional strategy

$$t\bar{t} + \not{E}_T$$



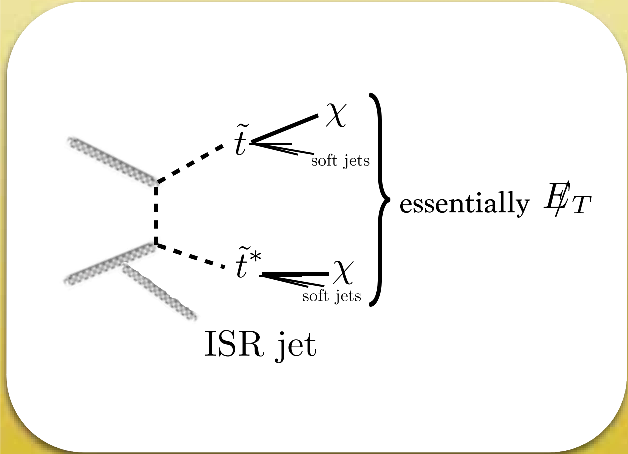


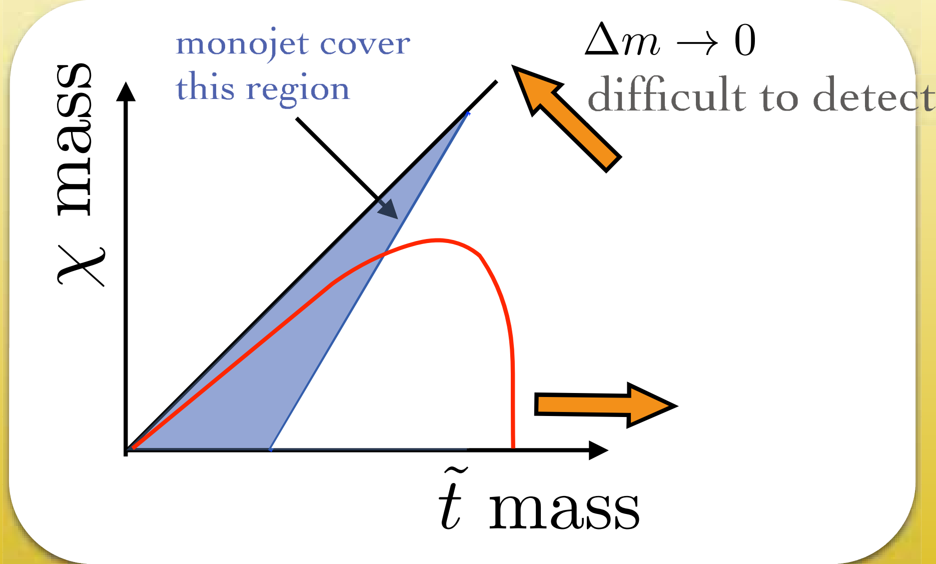
New physics searches in top sector at LHC

Michihisa Takeuchi (Kavli IPMU)

Monojet for compressed stops

$j + \not{E}_T$





New physics searches in top sector at LHC

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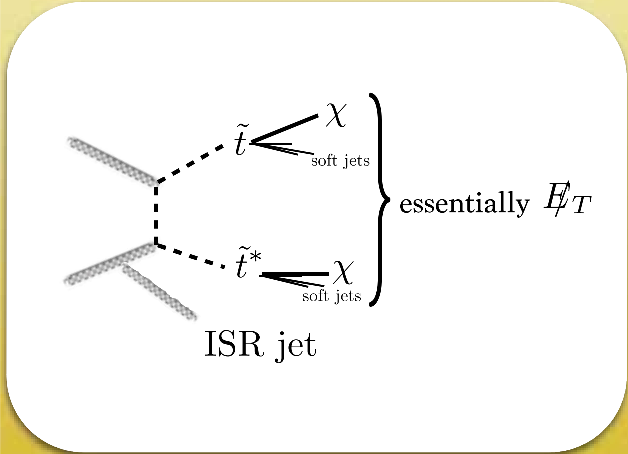
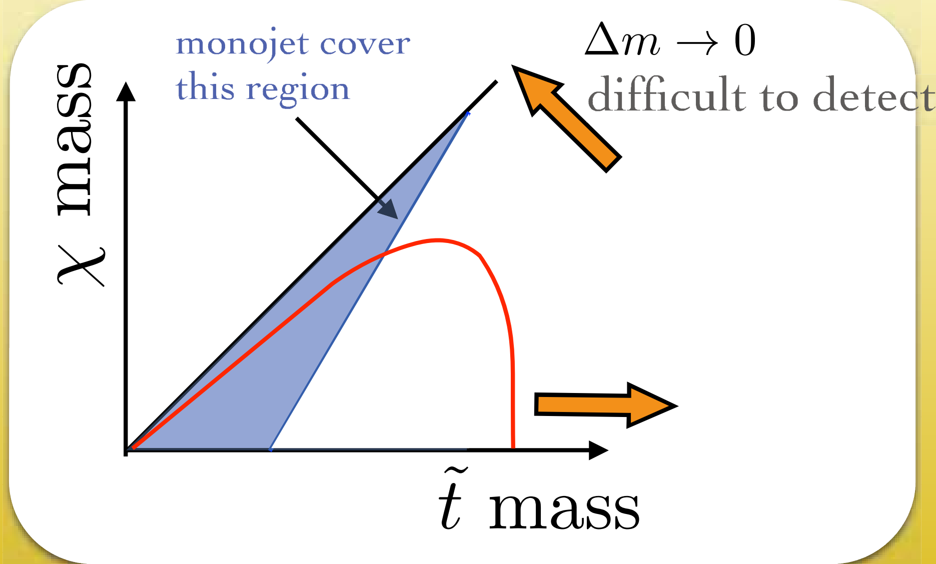
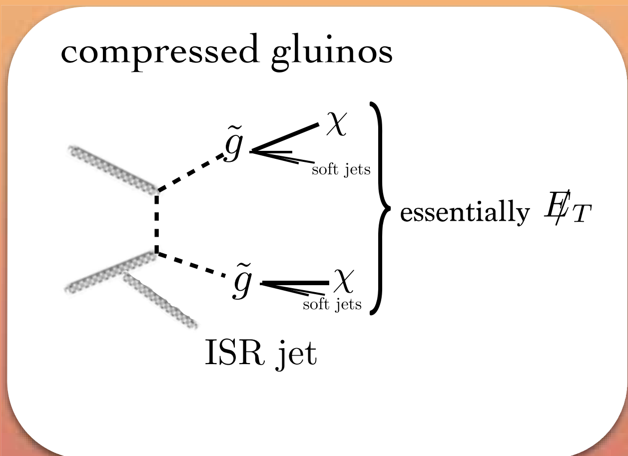
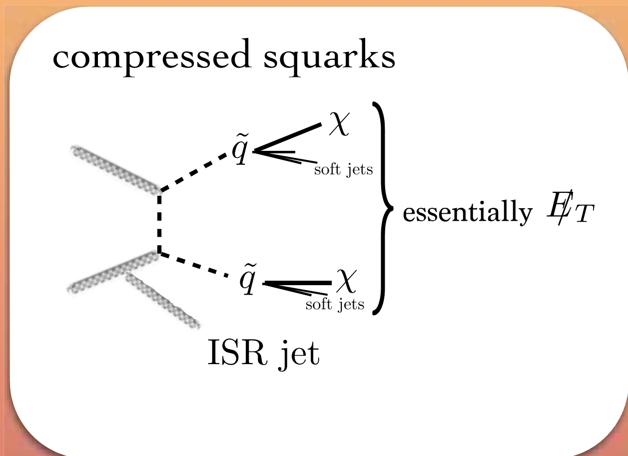




However, whatever compressed spectrum predicts mono-jet signature

$j + \not{E}_T$ also from

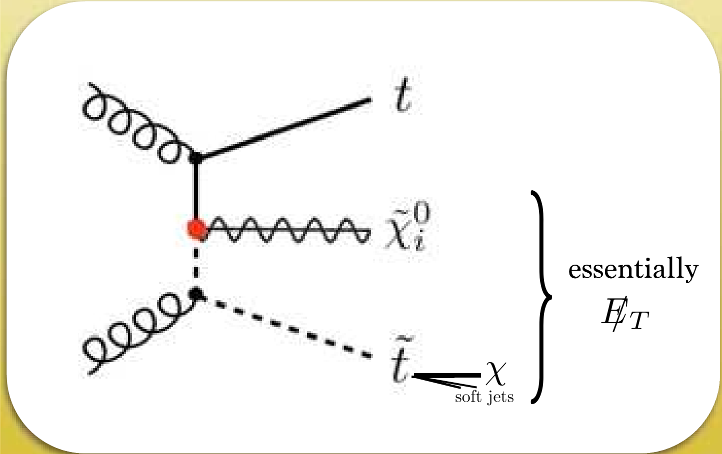




New physics searches in top sector at LHC

Michihisa Takeuchi (Kavli IPMU)

Mono-top as smoking-gun signature for compressed stops



$$t + \not{E}_T$$

only expected by compressed stops

New physics searches in top sector at LHC

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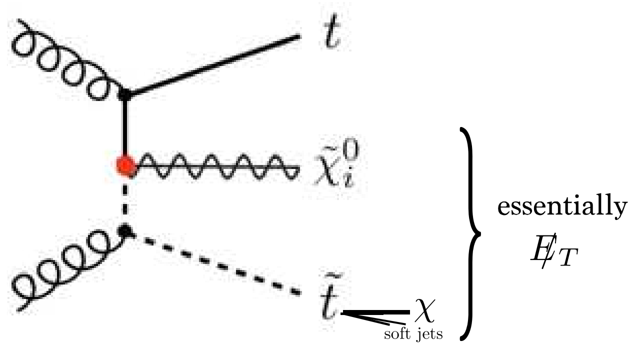
Mono-top as smoking-gun signature for compressed stops

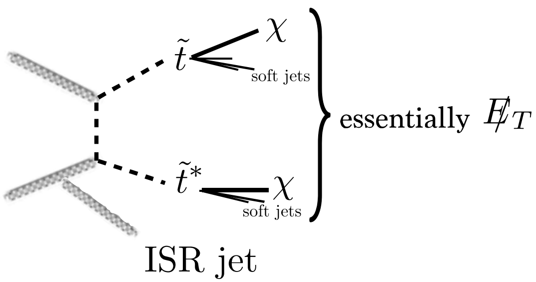


$$t + \not{E}_T$$

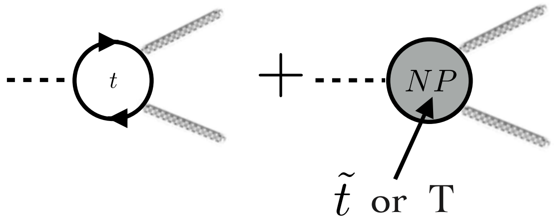
only expected by compressed stops

Various search strategies for new physics in top sector

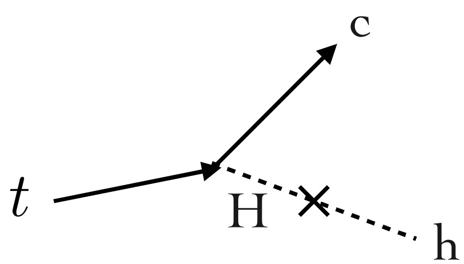
direct production



loop effects



flavor signatures



Many well motivated models predict first new signatures could be found especially in top sector.

Constraining the T2K Neutrino Flux with NA61/SHINE 2009 Replica-Target Data

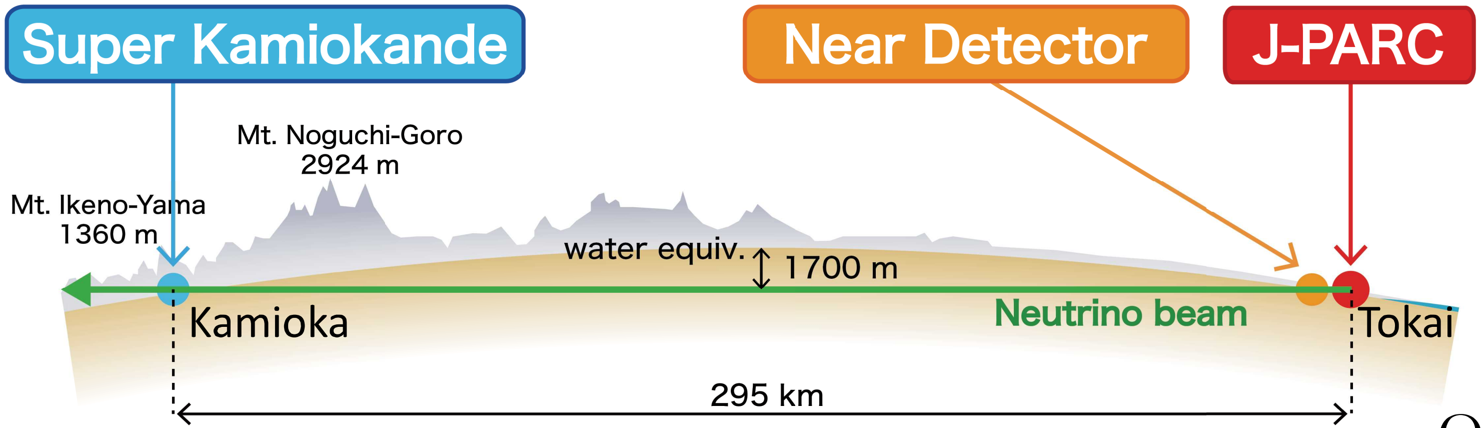
Tomislav Vladisavljevic

University of Oxford & Kavli IPMU

On behalf of the T2K Collaboration

The T2K Experiment

- T2K (Tokai-to-Kamioka): Long-baseline neutrino oscillation experiment located in Japan
- Measures ν_μ ($\bar{\nu}_\mu$) disappearance and ν_e ($\bar{\nu}_e$) appearance in ν ($\bar{\nu}$) mode
- Entering high-precision regime, current goal 3 sigma exclusion of CP-conserving phase
- Flux uncertainty constitutes one of the dominant systematics for oscillation analysis
- Precise knowledge of the flux is vital for neutrino cross-section measurements

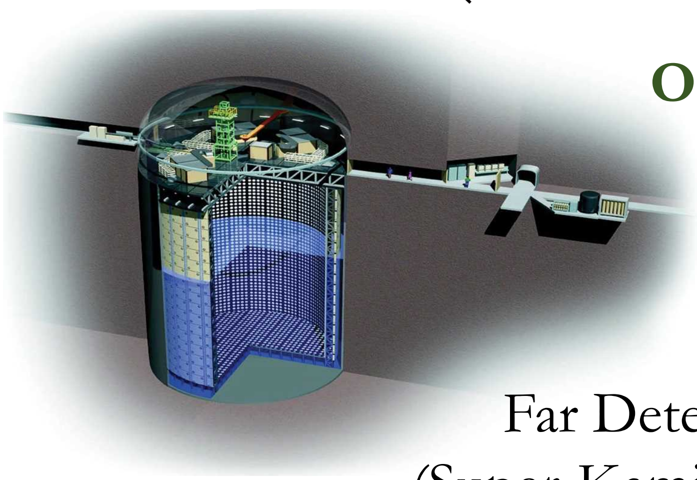


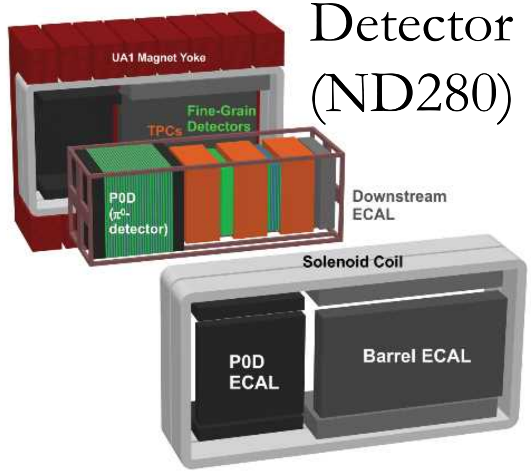
Off-Axis Near Detector (ND280)

Observed Number of Events

$$N_{\nu_e}^{SK} = P_{\nu_\mu \to \nu_e} \times \Phi_{\nu_\mu}^{SK} \times \sigma_{\nu_e}^{SK}$$

Flux Prediction

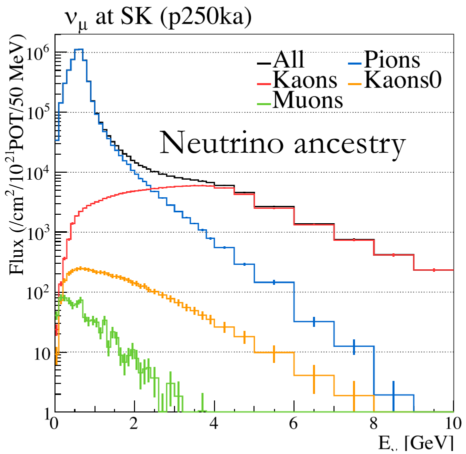


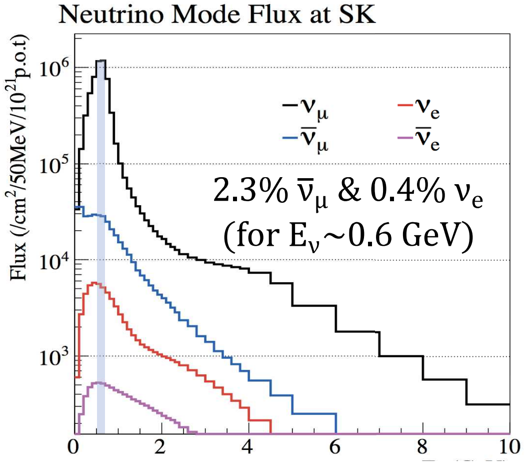


Far Detector (Super-Kamiokande)

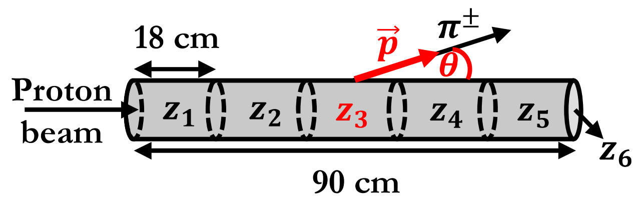
Constraining the T2K Neutrino Flux With NA61 Data

- Modelling hadronic interactions inside a long target is challenging
- The T2K flux prediction is constrained using NA61 **thin-target** data

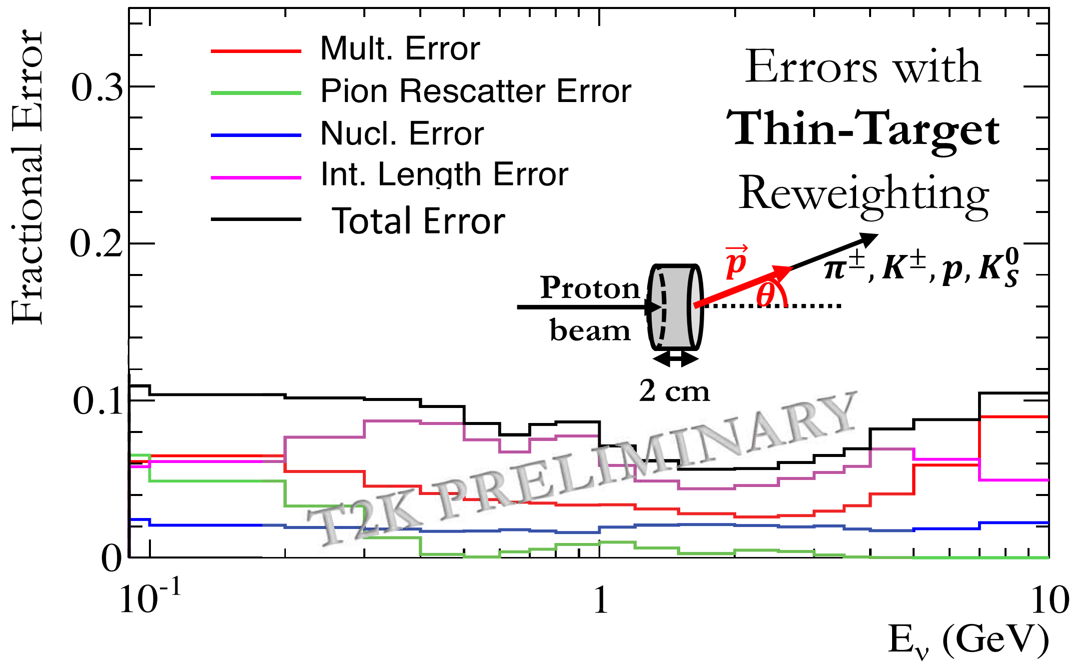


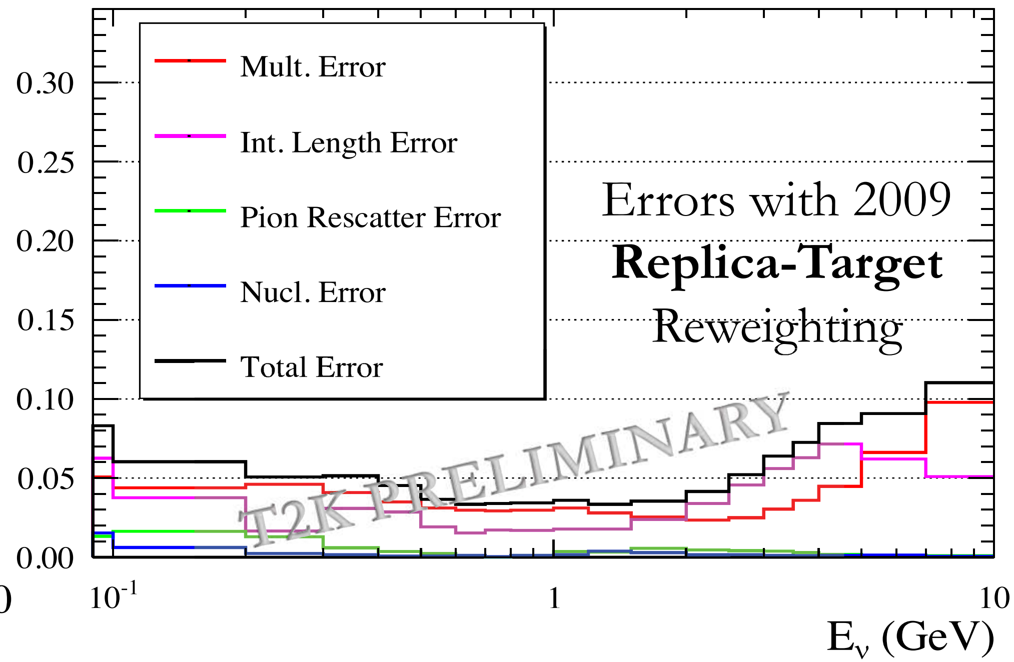


- Implementing **replica-target** data into the flux reweighting procedure reduces the flux uncertainties by ~50%



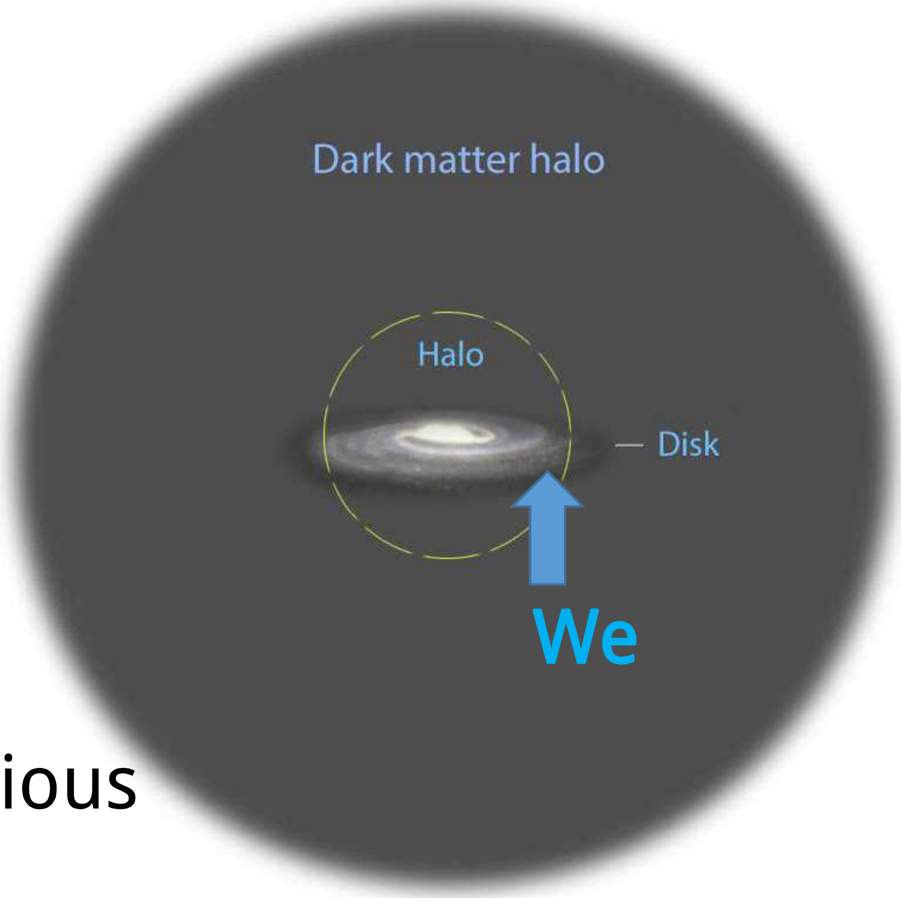
SK: Positive Focussing (ν) Mode, ν_μ





XMASS Results on WIMP Dark Matter

Benda Xu for XMASS Collaboration
Kavli IPMU, UTIAS, Univ. of Tokyo, Japan

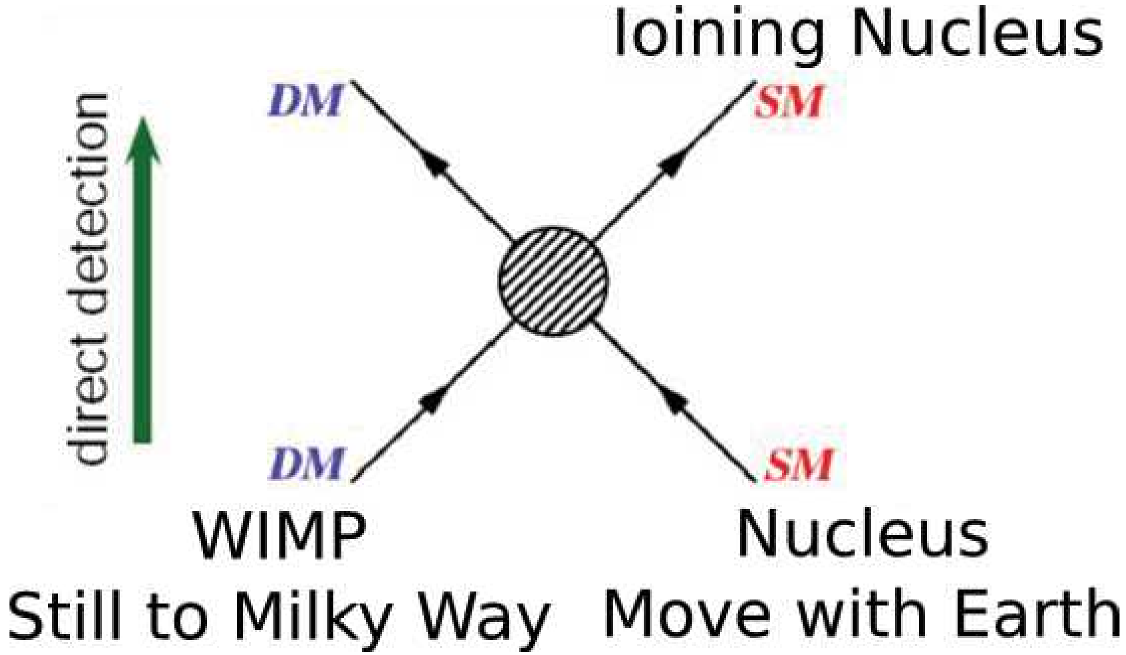


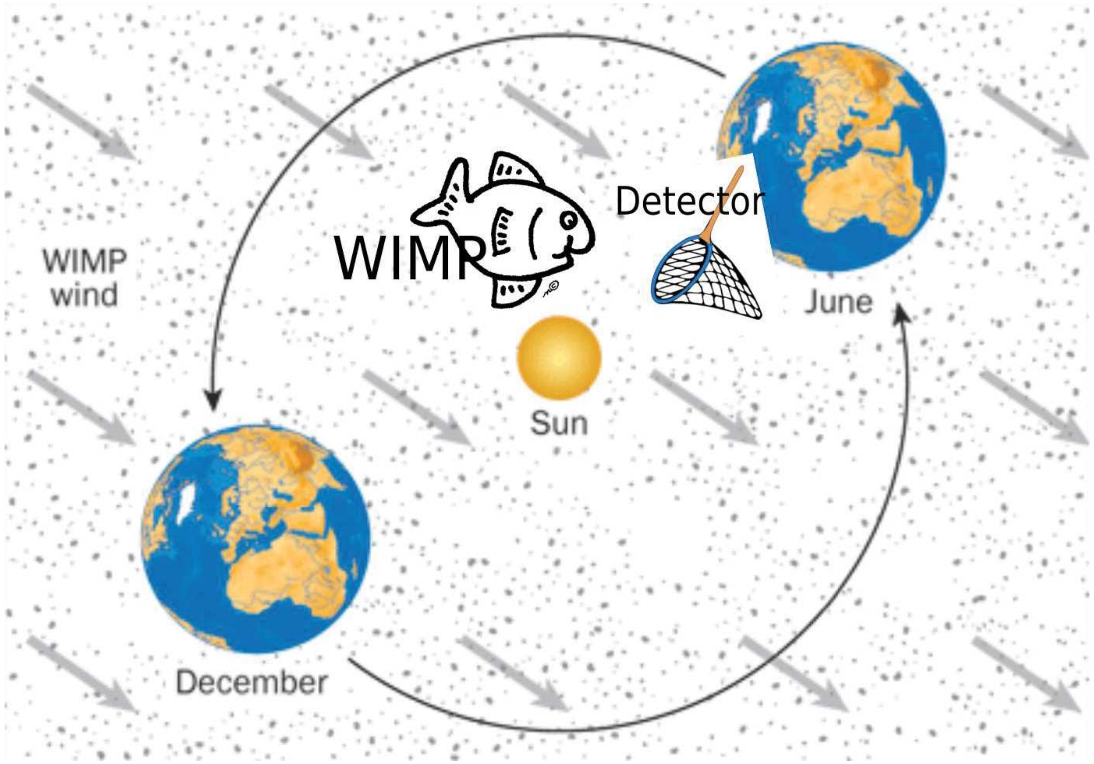
Dark matter is mysterious and ubiquitous.

Milky Way model

How to Catch Dark Matter?

- Nuclear Recoil

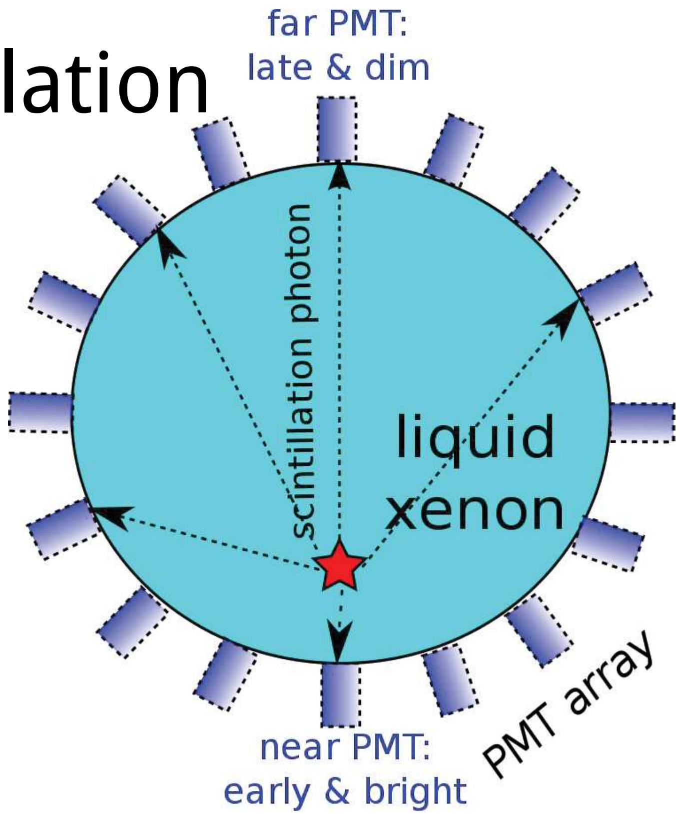




XMASS: A ~~Small~~ Fishnet at Kamioka Japan

- A calorimeter with position reconstruction
- 832kg liquid xenon target and scintillation
- Underground to shield cosmic ray

- Background: Radioisotopes
  - Checkout Benda Xu's poster.



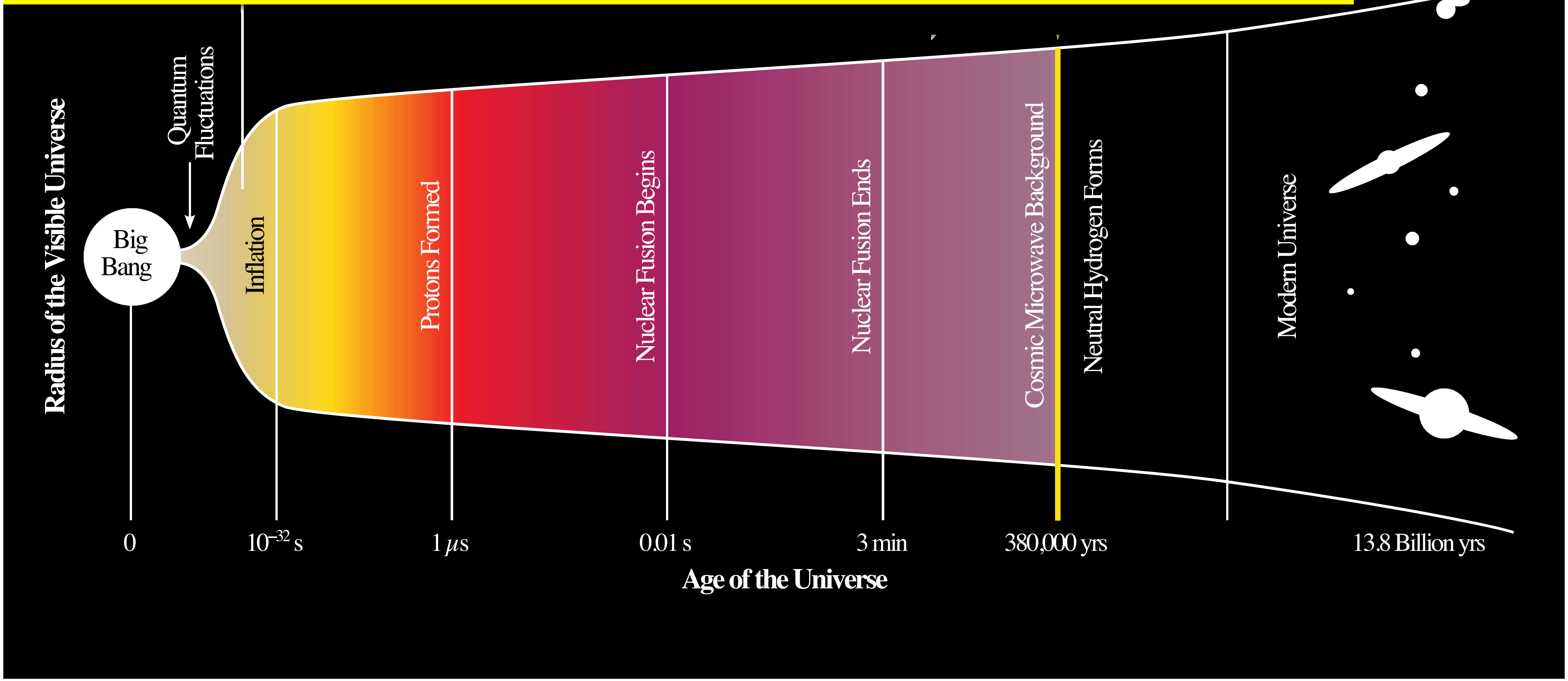
Anomaly constraints on QCD phase transition

Kazuya Yonekura

Kavli IPMU

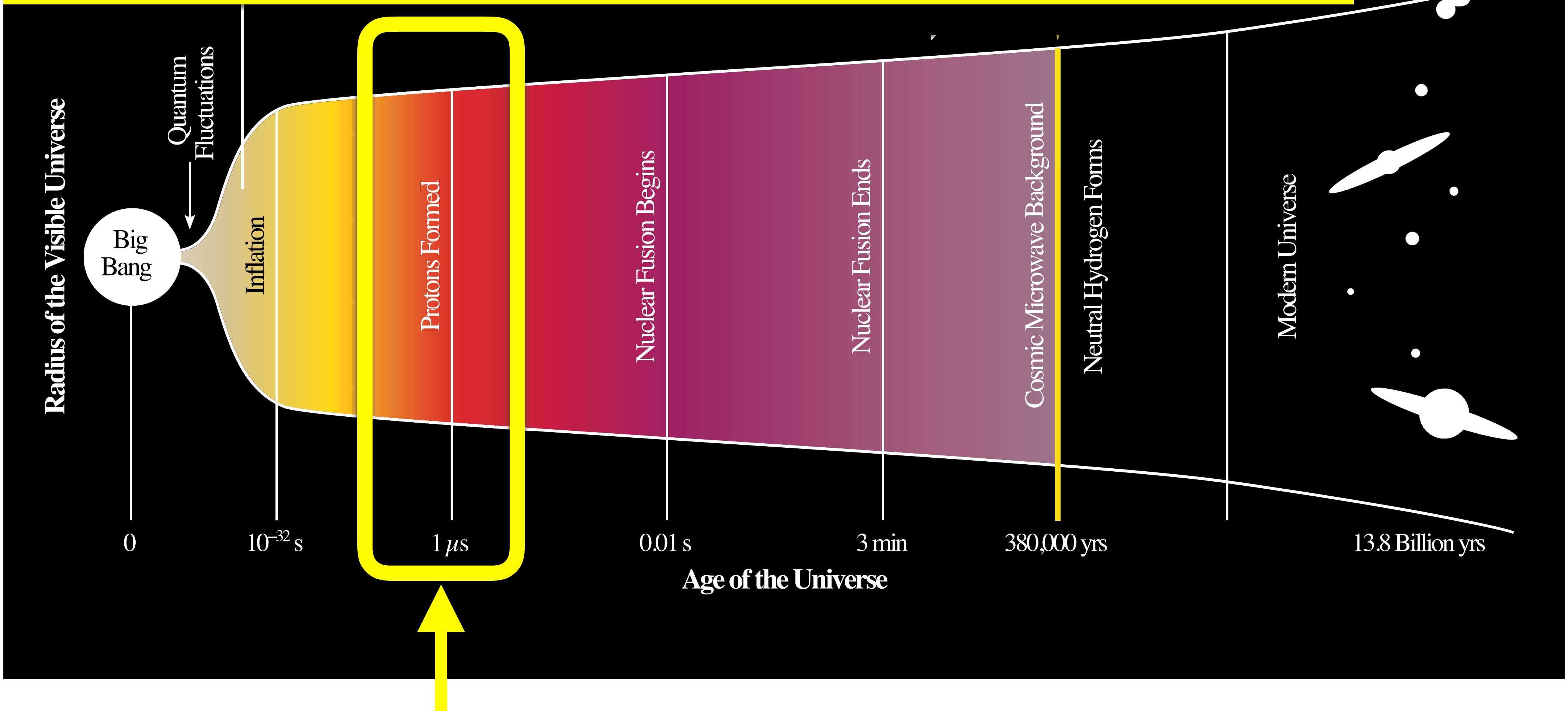
Based on [arXiv:1706.06104] with Hiroyuki Shimizu (IPMU)

Expansion of the Universe (From Wikipedia)



- Around the age 1μs, there was phase transition of the Universe due to Quantum Chromodynamics
- Dark matter from here!? (Quite disfavored by numerical simulation, but very optimistically…) [Witten,1984]

Expansion of the Universe (From Wikipedia)



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We (IPMUers) must study this phase transition of the universe around the age 1μs by using physics and mathematics!

We (IPMUers) must study this phase transition of the universe around the age 1μs by using physics and mathematics!

Why not?

So I studied it with Hiroyuki Shimizu, by using physics and a little bit of mathematics.

Quantum Chromodynamics (QCD)

$SU(N_c)$: color group ($N_c = 3$ in reality)

$SU(N_f)$: flavor group ($N_f = 2 \sim 3$ in reality)

Quarks: sections of fiber bundles with the structure group

$$G = [SU(N_c) \times SU(N_f)]/Z_{\mathrm{gcd}(N_c, N_f)}$$

A bit of topological techniques

- Obstruction theory of principal G-bundle

$$H^2(M_{\mathrm{spacetime}}, \pi_1(G))$$

- Atiyah-(Patodi-)Singer index theorem of Dirac operator

Two characteristic phenomena in QCD phase transition

Deconfinement

Chiral symmetry restoration

Two critical temperatures:

$T_{\rm chiral}$: chiral phase transition temperature (massless quark limit)

$T_{\rm deconfine}$: deconfinement temperature (subtle to define, see our paper)

The result:

In idealized case with well-defined $T_{\rm chiral}$ and $T_{\rm deconfine}$,

$$T_{\rm deconfine} \leq T_{\rm chiral}$$

The equality is possible only for 1st order transition

up to more exotic possibilities which I don't explain.

In theoretically (very) idealized situation, this result prefers Witten's scenario of dark matter via QCD!

Remark for experts:
This cannot be obtained from the usual perturbative anomaly.
We need more subtle global anomaly.
[Gaiotto-Kapustin-Komargodski-Seiberg,2017]