

FIPs 2020 website (we might decide to change picture though..)

27-29 May 2020
CERN
Europe/Zurich timezone

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Overview

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Feebly Interacting Particles (FIPs) are any new physics with coupling $\lll 1$.

With the maturation and establishment of the experimental programs searching for strongly-coupled physics at the LHC, there is an increasing interest in the broader particle and astrophysics community for feebly-interacting particles as a paradigm complementary to the strongly interacting sector at the TeV (or beyond) scale.

There are a multitude of initiatives that reflect the profound interest into this emerging field, including the [LHC Long-Lived Particle Community workshops and white paper](#), the [Physics Beyond Colliders initiative at CERN](#), recent studies for present and future neutrino experiments, and the recently published [Briefing Book of the European Strategy](#) update.

1 Fundamental Questions related to all FIPs

The fundamental questions below are the driving principles of the workshop and of the associated summary document which will be posted as proceedings on arXiv.

Which BSM problems FIPs can address, in particular:

1. Can feebly-interacting vector/scalar/pseudo-scalar particles be mediators between light DM (LDM) and SM particles?
2. Which ranges for DM and mediator masses and couplings are compatible with a DM thermal origin?
3. Which FIPs can provide DM candidates (axions, ALPs, sterile neutrinos, etc..)?
4. How DD and ID DM experiments together with reliable astrophysical and cosmological constraints can restrict the ranges in terms of mass and couplings for potential FIPs candidates?
5. How can dark matter detection experiments inform/guide energy and intensity frontier experiments, and vice versa?
6. Can FIPs be an answer to the question about the origin of neutrino masses and oscillations? If so, in which mass and coupling range?
7. Can FIPs have a role in baryogenesis (via leptogenesis or not) (eg: HNL, relaxion mechanism with CP-violating/conserving mixing, etc.)?
8. Can FIPs have a role in the EW symmetry breaking mechanism? Can FIPs have a role in the inflation?

My comment: we should be extremely well focused on fundamental questions, otherwise we risk to diverge. Focus is on the observational aspects of theory models: which are the models more compelling and what we can do to test them.

2 General considerations:

FIPs 2020 will be organized with a series of introductory talks setting the stage and sessions which follow the structure of "portals" used in the Physics Beyond Colliders and Briefing Book exercises. Each session will discuss recent theory developments and associated experimental results from all the involved communities (focus is on physics topics not experimental facilities). *We need to emphasize synergies and complementarities, we need a multi-scale approach with a broad and diversified experimental program.*

This structure has the advantage to associate to each portal some fundamental questions and discuss in the same session recent theory developments, and a wide variety of experimental results from very different communities (which will be "gently" forced to talk together and develop a common language).

Accelerator-based communities (colliders, fixed-target, beam-dump, neutrinos) are already used to the portal framework, DD and ID DM communities do not: we should keep them out of the portal framework, then make an effort to interpret their results within a benchmark model.

The outcome of the workshop will be elaborated proceedings where we will make the effort to present results within a given theory framework and produce a set of common plots, which will show clearly synergy and complementarity of different experimental approaches. The experimental results should be presented in a (as much as possible) model-independent way, in order to be reused following the fast theory developments. The proceedings will be updated every year following new experimental results and theory developments.

My comment: the outcome of the workshop are common plots/benchmarks in digested proceedings We should make the effort (and push the speakers) to develop a common language.

TENTATIVE AGENDA

START OF THE WORKSHOP: Wednesday 27 May, 1:30 pm

3 Introductory talks

At the beginning of the workshop we will have introductory talks (say, 30' each) setting up the scene on:

1. **Standard Model problems and FIPs from theoretical viewpoint (naturalness, etc);**
proposed speaker: *Raman Sundrum, Gilad Perez, Jonathan Feng, Christophe Grojean, Neal Weiner,*
time: 25'+5'
2. **What do we know about DM from a cosmological viewpoint?**
proposed speaker: *Annika Peter,*
Tracy Slatyer, Alexey Boyarsky, Carlos Frank (or the person he suggested), Mariangela Lisanti
time: 25'+5'
3. **Theory overview of DM models.**
proposed speaker: *Yonit Hochberg, Simon Knapen*
Tim Tait, Alessandro Strumia? Philip: Stefania Gori, Yoni Kahn possible replacements: *Geraldine*
Servant? Tongyan Lin? Felix Kahlhoefer? Kai Schmidt-Hoberg?
time: 25'+5'
4. **Search for FIPs at accelerator-based experiments (overview of different experimental techniques, showing complementarity and limitations of every approach)**
proposed speaker: *Tim Nelson?*
Brian Batell? Lesya Shchutska ? (or the person she suggested), Adam Ritz?
time: 25'+5'

COFFEE BREAK: 20', 3:50 - 4:10 pm

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5. Status and prospects of DM direct detection experiments in the low (< 10 GeV) mass range
proposed speakers: *Rouven Essig?* *Sabine Cebrian (Zaragoza)*
also *Laura Baudis (Zurich)*, *Tina Pollmann (Munich)* or *Karoline Schäffner (Munich)*. Other speakers more low-mass oriented: *Alexis Aguilar-Arevalo (UNAM)* or *Xavier Bertou (Bariloche)* (from DAMIC); *Federica Petricca (Ge-based detectors)*;
time: 25'+5'
6. Search for very (< 100 eV) low mass FIPs (atomic physics, quantum technologies, etc.).
proposed speakers: *Peter Graham*,
Surjeet Rajendran, *Kathryn Zurek*, *Gilad Perez*
time: 25'+5'
7. Status of stellar and astrophysics constraints on new (feebly-interacting) physics (covering vector, scalar, pseudo-scalar portals)
proposed speaker: *Georg Raffelt*
Other good names are A. Mirizzi or M. Giannotti
time: 25'+5'
8. [Early cosmology (BBN, reionisation, 21 cm) constraints on new (feebly-interacting) physics (covering vector, scalar, pseudo-scalar portals)]
proposed speaker: *Maxim Pospelov*.
Let's wait a moment before contact him, he could deserve a better talk. **time: 25'+5'**

SECOND DAY: Thursday 28 May, morning session: 9-12:30 pm

4 Feebly-interacting Heavy Neutral Leptons (Fermion portal)

Fundamental questions associated with this portal:

- Can HNLs explain the origin of neutrino masses and oscillations and in which mass/coupling range?
- Can HNLs be responsible of matter-antimatter asymmetry and in which mass/coupling range?
- Can an HNL be a DM candidate?

Proposed talks:

1. Theoretical introduction to seesaw models and their connection to leptogenesis (thermal, resonant and via neutrino oscillations), including 3-4 slides about phenomenology of HNL production/decays.
proposed speaker: *Pilar Hernandez, tbc*
time: 30+5
2. HNLs and their relation to astroparticle and cosmology (3.5 keV line, BBN, measurement of the absolute neutrino masses (KATRIN, Euclid, etc.).
proposed speaker: *Oleg Ruchayskiy, Asmaa Abada*
time: 20+5
3. HNLs and their relation (or non-relation) to active neutrino physics (PMNS, δ_{CP} , $0\nu\beta\beta$ decay, $m(\text{lightest neutrino})$,...);
proposed speaker: *Jacopo Lopez-Pavon, Marco Drewes*
time: 20+5

COFFEE BREAK

My comment: the order of the sessions is random, we can reshuffle them if needed....

COFFEE BREAK

4. Search for HNLs at extracted beams (neutrino experiments (T2K), NA62-kaon and dump, etc.);
proposed speaker: *someone from T2K including NA62 results and prospects for DUNE*
time: 15+5
5. Search for HNLs at LHCb, ATLAS, CMS
proposed speaker: *Lesya Shchutska (be must be careful to speakers' committees...)* .
time: 15+5
6. Prospects to search for HNLs with SHiP, including also MATHUSLA, FASER, CODEX-b projections
proposed speaker: *Nicola Serra, Kyrylo Bondarenko.*
time: 15+5
7. Prospects to search for HNLs at future *ee/ep/pp* colliders
proposed speaker: *Joel Jones-Perez, Stefan Antusch, Oliver Fischer.*
time: 15+5

LUNCH

5 Feebly-interacting Vector particles at large (not only kinetic mixing) (Vector portal)

Fundamental questions associated with this portal:

- Can feebly-interacting vector particles be mediators between LDM and SM particles?
- Which ranges for DM and mediator masses and couplings are compatible with a DM thermal origin?

Proposed talks:

1. Early cosmology (BBN, reionisation, 21 cm) constraints on new (feebly-interacting) physics (covering vector, scalar, pseudo-scalar portals)
proposed speaker: *Maxim Pospelov*.
Let's wait a moment before contact him, he could deserve a better talk.
time: 30'+5'
2. Search for LDM and vector mediators at accelerator-based experiments in US (HPS, BDX, Mini-Boone, LDMX);
proposed speaker: *Tim Nelson* (if he does not give the introductory talk).
time: 30+5'
3. Search for LDM and Vector/ALPs mediators at experiments at extracted beam lines (NA64, NA62, MESA) (mass range typically covered: < 1 GeV).
proposed speaker: *someone from NA64 covering also NA62, MESA*
time: 20+5'
4. Search for LDM and vector mediators at B-factories (mostly Belle-II, including old BaBar ad Belle results)
proposed speaker: *Christopher Hearty, Enrico Graziani? James: Abi Soffer;*
time: 20+5'

COFFEE BREAK

Coffee break at 4 - 4:30 pm

COFFEE BREAK

5. Search for LDM and vector mediators at LHCb, ATLAS and CMS;
proposed speaker: *Mike Williams*,
backup: *Antonio Boveia, Phil Ilten, Caterina Doglioni*
time: 20+5'
6. Search for LDM and vector mediators at FASER, CODEX-b, SHiP, MATHUSLA
proposed speaker: *someone from FASER*.
time: 20+5'

6 Other portal models

1. Overview talk about other portal models
proposed speaker: *Nathaniel Craig*
we propose to include other portal models in the first introductory talk, hence we delete this slot.
time: 30'+5'

SOCIAL DINNER: evening

7 Feebly-interacting pseudo-scalar particles at large (axions/ALPs)

Fundamental questions associated with this portal:

- Can feebly-interacting pseudo-scalar particles be mediators between LDM and SM particles?
- Which ranges for DM and mediator masses and couplings are compatible with DM thermal origin?
- To which extent axions/ALPs can be themselves DM candidates?

Proposed talks

1. Axions/ALPs as DM and/or light DM mediators: phenomenology
proposed speaker: *Anson Hook, Andreas Ringwald*
time: 25+5
2. Axions/ALPs as DM and/or light DM mediators: overview of experimental approaches in the low mass range.
proposed speaker: *Andreas Ringwald, Igor Irastorza*
time: 25+5
3. axions/ALPs phenomenology at accelerator-based experiments
proposed names: *Felix Kahlhoefer?, Kai Schmidt-Hoberg?*
time: 25+5
4. Astrophysics and cosmology: interpretation of bounds from BBN,CMB,SN1987,x-rays,..
proposed speaker: *Ben Safdi.*
It was proposed to split the talk in two, one for astrophysics and one for cosmology, suggestions for the second speaker?.
time: 25+5'

COFFEE BREAK: 20'

5. Search for axions/ALPs at accelerator-based experiments (NA64, NA62-dump, Belle-II, etc.): mass range 0.1-few GeV.
proposed speaker: *Babette Doeblich ?*
time: 20+5
6. Search for axions/ALPs at colliders (ATLAS, CMS, future colliders,..): mass range > 10 GeV.
proposed names: *Mathias Shot, Kohsaku Tobioka*
time: 20+5

LUNCH TIME

Probably these topics will be already covered by the speakers in the Vector portal session.



Light Dark Scalars (2/2)

Third Day, Friday 29 May, afternoon

Friday, 29 May, AFTERNOON SESSION: 2-4:30 pm

8 Feebly-interacting Scalar Particles at large (Scalar portal)

Fundamental questions associated with this portal:

- Can feebly-interacting scalar particles be mediators between light LDM and SM particles?
- Which ranges for DM and mediator masses and couplings are compatible with a DM thermal origin?
- Can light (less than Higgs mass) dark scalars be associated with the EW symmetry breaking mechanism? If so, how this would be modified by their presence?
- Can a light dark scalar be related to the inflation mechanism? If so, in which mass/coupling range?

Proposed talks

1. [Scalar portal and its connection to Higgs physics from a theory viewpoint](#)
proposed speakers: *Stefania Gori*
Gilad Perez, Simon Knapen, Kai Schmidt-Hoberg, Filippo Sala, David Curtin, Nathaniel Craig, Jared Evans, Jose Zurita.
time: 30+5
2. [Experimental constraints on the exotic Higgs width and direct searches for feebly-interacting dark scalars at ATLAS/CMS: status and prospects.](#)
proposed speakers: *Yuri Gershtein*
Larry Lee, Miriam Diamond.
time: 30+5
3. [\[Light dark scalar\(s\) and the inflation](#) proposed speaker: *Fedor Bezrukov*]. *Probably not pertinent to the workshop, which somehow should provide indication for possible future experiments.* **time: 30+5**
4. [Search for light feebly-interacting scalar particles at extracted beam lines \(SeaQuest @ FNAL, NA62, SHiP,...\)](#)
proposed speaker: *someone from NA62.*
time: 20+5
5. [Prospects to search for light feebly-interacting scalar particles at MATHUSLA, CODEX-b, SHiP](#)
proposed speaker: *someone from MATHUSLA.*
time: 20+5

COFFEE and END OF THE WORKSHOP: 4:30 pm.