Yong Du

Department of Physics, 426 LGRT
University of Massachusetts-Amherst
Amherst, MA 01003, USA
Date of Birth: November 24, 1990
Citizenship: People's Republic of China

Email: yongdu@umass.edu
Cell: +1-413-475-8129
Personal website: Click here

EDUCATION

Ph.D. in Physics 2015-2020
Department of Physics, University of Massachusetts-Amherst
Thesis Advisor: Michael J. Ramsey-Musolf; Academic Advisor: Jennie Traschen

Visiting scholar 2019-2020
CAS Key Laboratory of Theoretical Physics, Institute of Theoretical Physics, Chinese Academy of Science
Visiting advisor: Jiang-Hao Yu

Visiting scholar 2018
Department of Physics and Astronomy, University of Pittsburgh
Visiting advisor: Ayres Freitas

M.S. in Physics 2017
Department of Physics, University of Massachusetts-Amherst
Academic Advisor: Jennie Traschen

Visiting scholar 2014
Department of Physics, University of Massachusetts-Amherst
Visiting advisor: Michael J. Ramsey-Musolf

Ph.D. candidate in Physics (Transferred to University of Massachusetts-Amherst in 2015 fall) 2012-2015
School of Physics, Nanjing University
Advisor: Yeuk-Kwan Edna Cheung

B.S. in Physics 2008-2012
School of Physical Engineering, Zhengzhou University
Advisor: Er-Jun Liang

CURRENT RESEARCH INTERESTS

Phenomenology of various SM and BSM physics at current and future colliders; Electroweak radiative corrections at next-to-next-to-leading-order (NNLO) and/or above; Nature of particle dark matter and connection between particle physics and cosmology.

RESEARCH EXPERIENCE

- **Collider Studies:**
  - A real triplet is introduced to the SM Higgs sector to explain dark matter relic density. The model contains a long lived particle (LLP) with a distinct collider signature called "disappearing charged track" (DCT) to which the LHC is very sensitive. DCT constraints from current colliders rule out a triplet dark matter lighter than $\sim$800 GeV, way below the saturated mass ($\sim$2.5 TeV) from the relic density measured by Planck 2018. But constraints from direct detection from LUX, PandaX-II and XENONnT are much severer: A triplet dark matter lighter than $\sim$3 TeV is already ruled out by XENON1T. Looking into the future, XENON20T will probably lead to a direct observation of a real triplet dark matter up to $\sim$10 TeV.
  - A complex triplet is embedded in SM to explain matter-antimatter asymmetry of the universe and neutrino masses through a type-II seesaw mechanism. Discovery and Higgs portal parameter determination of this model is studied in great detail at current and future 100 TeV circular colliders (FCC). With the proposed luminosity for a 100 TeV circular collider, a triplet up to $\sim$5 TeV can be discovered at FCC through the same-sign di-lepton channel. On the other hand, the Higgs portal parameters related to electroweak baryogenesis would be constrained to be within $\sim$[-1, 1] from precision measurements on the $h \to \gamma\gamma$ decay rate at FCC.
- **NNLO Electroweak Radiative Corrections:**
  - The Møller project at the Jefferson Lab is now funded to solve the 3σ disagreement between the current two most precise near Z-pole measurements on the weak mixing angle from SLC and LEP. The proposed precision level at the Jefferson Lab requires NNLO contributions from SM to be included. We have calculated all topologies with at least one closed fermion loop at NNLO and find that sum of NLO and NNLO contributions are below the precision level proposed at the Jefferson Lab due to accidental cancellation. Bosonic contributions are also estimated and we find that they are negligible.
  - In order to explain the 3.6σ deviation from SM prediction measured by E821 at the Brookhaven National Laboratory, contributions to $(g-2)_\mu$ from the Two Higgs Doublet model (2HDM) at NNLO are calculated in a non-liner R_ξ gauge explicitly. Dominant contributions from Barr-Zee type diagrams are calculated with the pinch technique being applied to cancel out any gauge depending terms in our results. We, however, get scooped during the process of checking gauge cancellation.
- **Dark Matter:**
  - Besides the real triplet dark matter project mentioned above, since experimental constraints on WIMP dark matter are more severe, we have also been working on dark matter scenarios at or below the sub GeV scale, where the dark matter is produced through freeze-in first with a pseudo-scalar mediator between the SM sector and the dark sector. The dark matter then freezes out from the dark sector as the universe expands. Testability of such a scenario for low-mass direct detection is now under active study in our group and we are approaching the end of this project.

SELECTED TEACHING

- PHY811: Field Theory I (Grader)
- PHY605: Methods of Mathematical Physics (Grader)
- PHY424: Quantum Mechanics (Grader)
- PHY281: Computational Physics (Grader)

PUBLICATIONS

1. Yong Du, F. Huang, H.-L. Li and J.-H. Yu, "Freezing-in Dark Matter from Secret Neutrino Interactions" , arXiv:2005.01717
2. C.-W. Chiang, G. Cottin, Yong Du, K. Fuyuto and M. J. Ramsey-Musolf, "Collider Probes of Real Triplet Scalar Dark Matter" , arXiv:2003.07867
3. Yong Du, A. Freitas, H.H. Patel and M. J. Ramsey-Musolf, "Parity-Violating Møller Scattering at NNLO: Closed Fermion Loops" , arXiv:1912.08220
4. Yong Du, A. Dunbrack, M. J. Ramsey-Musolf and J.-H. Yu, "Type-II Seesaw Scalar Triplet Model at a 100 TeV *pp* Collider: Discovery and Higgs Portal Coupling Determination" ,JHEP 1901 (2019) 101.

TALKS

1. The XXIX International Conference on Neutrino Physics and Astrophysics (Neutrino 2020, June-July 2020)
   Chicago, Illinois USA (Online conference due to COVID-19)
   Poster presentation: **Freeze-in Dark Matter from Secret Neutrino Interactions**
2. The Seventh Dark Matter@LHC 2020 Workshop (DM@LHC, June 2020)
   DESY, Hamburg, Germany (Online conference due to COVID-19)
   Plenary talk: **Probing the real triplet scalar dark matter at colliders**
3. The Seventh Workshop of the LHC LLP Community (LHC LLP, May 2020)
   CERN (Online conference due to COVID-19)
   Plenary talk: **Collider probes of real triplet scalar dark matter**
4. The Eighth Annual Large Hadron Collider Physics (LHCP2020, May 2020)
   International Conference Centre of Sorbonne Universite, Paris, France (Online conference due to COVID-19)
   Theory poster presentation in the "Dark Sector BSM": **Collider probes of real triplet scalar dark matter**
5. Phenomenology 2020 Symposium (May 2020)
   University of Pittsburgh, PA, USA (Online conference due to COVID-19)
   Parallel talk: **Collider probes of real triplet scalar dark matter**

6. LoopFest XVIII (August 2019)
   Fermilab, IL, USA
   Parallel talk: **Two-loop fermionic contributions to polarized Moller scattering asymmetries**

7. Opportunities at Future High Energy Colliders (June-July 2019)
   IFT, Madrid, Spain
   Parallel talk: **Type-II seesaw scalar triplet at a 100 TeV pp collider**

8. Phenomenology 2019 Symposium (May 2019)
   University of Pittsburgh, PA, USA
   Parallel talk: **Type-II seesaw scalar triplet at a 100 TeV pp collider**

9. Seminar talk (April 2019)
   University of Massachusetts-Amherst, MA, USA
   Minimal dark matter at a 100 TeV collider

10. Seminar talk (November 2018)
    University of Massachusetts-Amherst, MA, USA
    Type-II seesaw scalar triplet at a 100 TeV pp collider

GRANTS

- Graduate Student Travel Grant, Department of Physics, University of Massachusetts-Amherst, $600 (2019).
- National University Student Innovation Program, Ministry of Education of the People's Republic of China, RMB 40,000 (PI 2010 - 2012).

SKILLS

- **Computing Skills:**
  - **Mathematica**: Developed own Mathematica code to do 2-loop Feynman integral calculation based on expansion by regions and applied code to the Møller project.
  - **Python**: Developed own Python and Mathematica code for dark matter relic density calculation (for both freeze in and/or freeze out) with a feature of 2D scanning. Developed own Python code to automatically calculate AT&T bills for a group of ten users.
  - **REDUCE, LanHEP, CalcHEP, FeynRules, MicrOMEGAs**: Using a combination of these packages, checked gauge invariance of standard model, the real triplet model and applied skills to the real triplet project.
  - **MadGraph, Delphes, Pythia, ROOT, C++, C, bash**: Using a combination of these packages/languages, dealt with event size of $\mathcal{O}$ (TB) for the complex triplet project.
  - **Also very familiar with**: FeynArts, Package-X, FIRE, COLLIER, FeynCalc, LoopTools– Actively interacted with one or all of those packages while working on the complex triplet, the real triplet and the Møller project.

  - **Also familiar with**: CLASS, MontePython–Ran through built-in examples, now adapting the CLASS package for one scenario where the Hubble tension between Planck result and local measurements from SH0ES and H0LiCOW can be explained.

- **Language:**
  - English (fluent–about five years' experience with teaching physics labs at University of Massachusetts-Amherst.)
  - Mandarin (native)

AWARDS

- **May 2013**, Freshman Scholarship for Graduate Students, Nanjing University (Awarded to top 5)
- **Oct. 2011**, National English Contest for College Students, National Rank: 3, Zhengzhou University
- **2011**, first-class scholarship, Zhengzhou University
- **Sep. 2010**, National Computer Examination Certificate, 2 Grade, C programming Language, Zhengzhou University
- **2010**, National Endeavor Fellowship, Zhengzhou University
- **2009**, second-class scholarship, Zhengzhou University
- **2009**, Merit Student, Zhengzhou University

REFERENCES

Ayres Freitas
Pittsburgh Particle-physics Astro-physics & Cosmology Center (PITT-PACC),
Department of Physics & Astronomy,
University of Pittsburgh, Pittsburgh, PA 15260, USA
Phone: 1-412-624-9060
Email: afreitas@pitt.edu

Michael Ramsey-Musolf
Amherst Center for Fundamental Interactions, Department of Physics,
University of Massachusetts-Amherst
Amherst, MA 01003, USA
Phone: 1-413-545-0320
Email: mjrm@physics.umass.edu

Jiang-Hao Yu
CAS Key Laboratory of Theoretical Physics, Institute of Theoretical Physics,
Chinese Academy of Science, Beijing 100190, P.R. China;
School of Physical Science, University of Chinese Academy of Sciences,
No. 19A Yuquan Road, Beijing 100049, P.R. China;
Phone: 86-010-62551799
Email: jhyu@itp.ac.cn