Mustafa Mustafa

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Work Experience

2016/Oct-Present **Data Postdoctoral Fellow - HEP center of computing excellence**
National Energy Research Scientific Computing Center, Berkeley Lab.
Roles:
- Investigating applications of Deep Learning (Generative Models) to scientific simulations (Simulators Emulators).
- Coordinating benchmarks of TensorFlow optimized for Intel Xeon architectures on Cori HPC system.
- Consulting and development projects to facilitate the migration of data-intensive High Energy Physics experiments workflows to many-core HPCs (Cori-KNL).

2013-2016 **Physicist Postdoctoral Fellow**
RNC, Nuclear Science Division, Berkeley Lab.
Member of the (STAR) Experiment
I worked on a range of projects associated with the collection, reconstruction, preprocessing and data analysis of large heavy-ion collisions datasets (~petabytes) collected by the STAR detector at the Relativistic Heavy Ion Collider, BNL, NY. The ultimate goal of my projects was to carry measurements of charmed hadrons differential production in heavy ion collisions which helps to characterize the properties of the medium created in the collisions (possibly a Quark Gluon Plasma). Areas of research and contributions during this position:
- Experimental physics; heavy quarks and heavy-ions physics
- Large-scale data analysis
- Detector calibration & alignment
- Fast data-driven Monte Carlo simulations
- Software design & development
- C++(11) coding guidelines & development practices
- Data production pipeline(s) (on traditional clusters and HPC)

Education

2009-2013 **Ph.D. in High Energy Nuclear Physics**
Purdue University, IN.

2004-2008 **B.Sc. in Physics**
University of Jordan, Amman, Jordan.

Talks

Conference talks/posters:

2017/10 **Towards a cosmology emulator using Generative Adversarial Networks**,
Bay Laern 2017, Apple campus, Cupertino, CA.

2015/10 **Overview of recent results from the STAR experiment**,
Quark Matter 2015 International Conference, Kobe, Japan. PDF.

2013/11 **Measurement of non-photonic electrons in STAR experiment**,
EMMI workshop on Heavy Flavor & QCD Phase Structure in High Energy Collisions.,
LBL, Berkeley, CA. PDF.

2012/08 **Measurements of non-photonic electrons at STAR experiment**,
parallel talk at *Quark Matter 2012 International Conference*, Washington D.C. PDF.

Invited talks & seminars:

2017/10 **Towards a cosmology emulator using Generative Adversarial Networks**,
AI@SLAC, Stanford University, CA. PDF.

2014/06 **Recent open heavy flavor results from STAR experiment**,
RHIC & AGS Annual Users' Meeting, BNL, NY. PDF.

2013/06 **Recent open heavy flavor results at RHIC**,
RHIC & AGS Annual Users' Meeting, BNL, NY. PDF.

2012/10 **Measurements of non-photonic electron in STAR experiment**,
Int. Workshop on Heavy Quark Production in Heavy-Ion Collisions, Utrecht, Netherlands. PDF.

2012/08 **Measurements of non-photonic electron in STAR experiment**,
Workshop on Heavy Flavor Production in High-Energy Nuclear Collisions, UIC, Chicago, IL. PDF.

2014/08 **Measurements of electrons from heavy-flavor hadrons decays in STAR experiment**,
University of Illinois at Chicago, Chicago, IL. PDF.

Publications

75+ publications. Full list available at Google Scholar: https://goo.gl/GKCE35 or INSPIRE: https://goo.gl/yExHIf.

Selected computing publications:

2017 *Creating Virtual Universes Using Generative Adversarial Networks*.
Mustafa Mustafa et al. Under review for publication, arXiv:1706.02390.

2017 *STAR Data Reconstruction at NERSC/Cori, an adaptable Docker container approach for HPC*.
Mustafa Mustafa et al. Journal of Physics 898, Track 6, Infrastructures..

2017 *Shifter: Containers for HPC*.
Lisa Gerhardt at al. Journal of Physics 898, Track 6, Infrastructures..

Selected experimental physics publications:

2017 *Measurement of D^0 Azimuthal Anisotropy at Midrapidity in Au+Au Collisions at $\sqrt{s^{NN}} = 200$ GeV*.
L. Adamczyk et al. (STAR Collaboration). Physical Review Letters 118, 212301.

2015 *Overview of recent results from the STAR experiment*.
Mustafa Mustafa (for the STAR Collaboration). Nuclear Physics A. arXiv:1512.09329.

2013 *Measurements of non-photonic electron production and azimuthal anisotropy in $\sqrt{s^{NN}} = 39$, 62.4, and 200 GeV Au+Au collisions from STAR at RHIC*.
Mustafa Mustafa (for the STAR Collaboration). Nuclear Physics A 904-905, 665 (2013). arXiv:1210.5199.

2012 *Measurements of D^0 and D^* production in p + p Collisions at $\sqrt{s}$ = 200 GeV*.
L. Adamczyk et al. (STAR Collaboration). Phys. Rev. D 86, 072013 (2012). arXiv:1204.4244.

Mathematical physics publications:

2011 *Supersymmetry identifies molecular Stark states whose eigenproperties can be obtained analytically*.
M. Lemeshko, M. Mustafa, S. Kais, B. Friedrich. New J. Phys. 13, 063036 (2011). arXiv:1106.4402.

2011 *Supersymmetric factorization yields exact solutions to the molecular Stark effect problem for "stretched" state*.
M. Lemeshko, M. Mustafa, S.Kais, B. Friedrich. Phys. Rev. A. 83, 043415 (2011). arXiv:1105.5262.

2009 *A Venn diagram for supersymmetric, exactly solvable, shape invariant, and Infeld-Hull factorizable potential*. M. Mustafa, S. Kais. arXiv:0911.4206.

2009 *Effective polar potential in the central force Schrödinger equation*.
M. S. Shikakhwa and M. Mustafa. Eur. J. Phys. 31, 151 (2010). arXiv:1001.3693.

Book chapters:

2009 *General Physics, Electromagnetism Laboratory Manual, 3rd Edition*.
M. S. Shikakhwa, M. Mustafa, R. Al-Rfou', A. Ecevit, M. Ozbakan.
Middle East Technical University, North Cyprus Campus.

Projects and Contributions

Selected ongoing projects:

2016-Present **GANs for Cosmology Mass Maps**

Objective:	To investigate the capabilities of GAN to produce cosmological mass density maps.
Contributions:	Main researcher.
Technologies:	Deep Learning, Generative Models, GANs, TensorFlow

2016-Present **STAR data production at Cori (NERSC)**

Objective:	To process 3Pb of raw data that uses 35M core-cpu hours at Cori HPC system.

Contributions:	Developing a fault-tolerant workflow pipeline.
Technologies:	Docker/Shifter, MongoDb

Completed projects:

2015-2016: **Data Driven Fast Simulator**

Objective:	Reliable simulation of the Heavy Flavor Tracker efficiency, acceptance and spatial resolution performance.
Contributions:	Developed a first of its kind and scale, data-driven simulation package.
Outcome:	The Fast Simulator. As opposed to ab-initio simulations, the Fast Simulator uses an input from data to simulate the HFT real performance. In addition to the superior accuracy of the data-driven approach, it cuts the computation time of traditional simulations by more than a 7000x.
Skills:	Monte Carlo simulations. Understanding of Time Projection Chambers and Silicon Trackers, their calibration and alignment.

2015-2016: $D^0/D^{\pm}$ **Azimuthal Anisotropy and Spectra in Au+Au collisions using Heavy Flavor Tracker**

Objective:	High precision measurement of open charm observables in heavy ion collisions using the newly installed Heavy Flavor Tracker.
Contributions:	Main author of Pico Heavy Flavor Analysis Library and Data Driven Fast Simulator.
Outcome:	First measurement of D^0 azimuthal anisotrpy and high precision measurement of nuclear modification factors. Results have been presented at Quark Matter 2015 conference. D^0 and $D^{\pm}$ spectra are being finalized for publication.

2014-2016 **Heavy Ion Tea (HIT) seminars series (LBNL)**

Objective:	Organization of HIT seminars which are hosted by the (RNC) group at LBNL.
Contribution:	As a committee member I am involved in seminars program preparation and organization, identifying and inviting speakers.
Skills:	Staying current in High Energy Particle and Nuclear Physics. Effective communication with committee members and speakers candidates.
Outcome:	Fall 2014 - Spring 2016 diverse and active seminar series.

2015 **C++11 STAR coding guidelines committee**

Objective:	Revise STAR coding standard to provide guidance and recommendation for usage of C++11 new features.
Contribution:	As a member of the committee, I reviewed: Range-`for` statements. Override controls: `override` and `final`. Smart pointers. Move semantics/rvalue reference. Control of defaults: `default` and `delete`, move and copy. In-class members initialization.
Skills:	Knowledge of C++, STAR coding standards. Learning enough about C++11 standards to make informed recommendations.
Outcome:	Coding guidelines. Formatting guidelines

2015 **Time Projection Chamber (TPC) alignment and calibration (STAR experiment)**

Objective:	Carry R&D on alignment and calibration of STAR TPC (50% of my postdoc appointment at LBNL).
Contributions:	TPC gas $\omega\tau$ and field distortion correction coefficients measurement using lasers data and verification using Magboltz simulations. TPC alignment vetting using HFT and cosmic rays data.
Skills:	Knowledge of TPC operation, physics and design. TPC calibrations and alignment techniques. Expertise on STAR software infrastructure.

2012-2014 **Heavy Flavor Tracker - PXL simulators (STAR experiment)**

Objective:	Development and deployment of STAR Heavy Flavor Tracker (HFT) new silicon secondary vertex tracker (PXL) simulators.

Contributions:	Designed and implemented: 1) Simulation data containers 2) Simulators interface 3) Fast simulator 4) Pile up hits adder 5) STAR wrapper for DIGMAPS sensors response emulation tool. Maintaining the software package.
Skills:	Simulation. Software architecture. Knowledge of STAR software architecture. OOP, C++, software design.
Outcome:	STAR PXL simulation software. github, STAR documentation.

2014 **MTD simulation software code review (STAR experiment)**

Objective:	Verify compliance of StMtdSimMaker code with the STAR coding guidelines and C++ standards.
Technical skills:	Knowledge of C++ and STAR coding standards.

2013 **FGT point maker code review (STAR experiment)**

Objective:	Verify compliance of StFgPointMaker code with the STAR coding guidelines and C++ standards.
Technical skills:	Knowledge of C++ and STAR coding standards.

2014-2015 **Measurement of non-photonic electrons in U+U collisions (STAR experiment)**

Objective:	Measurement of non-photonic electrons production in U+U collisions at $\sqrt{s}$=193 GeV.
Contribution:	Mentoring Masters student Katarína Gajdošová (Czech Technical University, Prague).
Skills:	Teaching and mentorship.
Outcome:	Preliminary results will be presented at the 53rd International Winter Meeting on Nuclear Physics, Borimo, Italy. (Jan/2015).

2013-2014 **Charm production in p+p collision at $\sqrt{s}$ = 200 GeV (STAR experiment)**

Objective:	Measurement of charm production at mid-rapidity by direct reconstruction of $D^0 \rightarrow K\pi$ and $D^* \rightarrow D^0 \pi \rightarrow K\pi\pi$ from RHIC year 2012 run.
Contribution:	Hao Qiu and I carried out the entire analysis.
Technical skills:	Large data analysis. PYTHIA. ROOT, OOP, C++, computer clusters.
Outcome:	Preliminary results were presented at Quark Matter 2014 (PDF).

2013-2015 **Measurement of non-photonic electrons in p+p collisions (STAR experiment)**

Objective:	Measurement of non-photonic electrons production in p+p collisions at $\sqrt{s}$=200 GeV from RHIC year 2012 run.
Contribution:	Mentoring Ph.D. student Xiaozhi Bei (UIC and CCNU).
Skills:	Teaching and mentorship.
Outcome:	Poster at Quark Matter 2014. Paper in preparation.

2011-2013 **Measurement of non-photonic electrons production and azimuthal anisotropy (STAR experiment)**

Objective:	Measurement of non-photonic electrons production and azimuthal anisotropy in Au+Au collisions at $\sqrt{s^{NN}}$=200, 62.4 and 39 GeV.
Contribution:	PicoDst production. Data quality assurance. Electrons identification. Data analysis for spectra part. Embedding and efficiency studies.
Technical skills:	Large data analysis. Statistical methods. Simulation. PYTHIA. OOP, C++, ROOT, scripting.
Outcome:	Ph.D. thesis. arXiv:1210.5199. arXiv:1405.6348.

2010-2013 **Embedding Deputy (STAR experiment)**

Objective:	Train and follow-up with Embedding Helpers on embedding productions. Quality assurance of production physics and detector performance in simulation vs. data. Follow-up on issues and bugs with the core Software and Computation team.

	Skills:	Effective communication. Team management. Knowledge of STAR data simulation and reconstruction code base. C++, scripting.
	Outcome:	Identified and helped solve several software bugs. Restructured the embedding workflow by refactoring submission and production management tools. Finished a two-year backlog of requests in 6 months.

2010-2011 **D^0 production in p+p collision at $\sqrt{s}$ = 200 GeV (STAR experiment)**

Objective:	Measurement of charm cross-section at mid-rapidity by direct reconstruction of $D^0 \to K\pi$.
Contribution:	Studying event-mixing techniques in p+p collisions. Cross-checking signal reconstruction. STAR documents.
Technical skills:	Large data analysis. PYTHIA. ROOT, C++, computer clusters.
Outcome:	Phys. Rev. D 86, 072013 (2012). arXiv:1204.4244.

2008 **Theoretical Physics Lab. Linux Cluster (University of Jordan)**

Objective:	Constructing the first Linux Cluster in the University of Jordan for computation physics research.
Contribution:	Organized and lead a group of physicists and engineers to carry the task.
Skills:	Leadership. Linux administration, networking, cluster infrastructure.
Outcome:	We completed the construction of two clusters.

Work History:

Research:

2010-2013 **Graduate Research Assistant. High-Energy Nuclear Physics Group.**
Purdue University, IN.
The primary focus of my research was heavy quarks interaction with the strongly interacting partonic medium created in heavy-ion collisions so-called Quark Gluon Plasma.

2008-2009 **Research Assistant. Remote collaboration with Prof. Sabre Kais.**
Purdue University, IN.
Applications of Supersymmetric Quantum Mechanics techniques to problems in Atomic and Molecular Physics. This work has been initiated during my Dec. 2008 research visit to Max Planck Institute for Physics of Complex Systems, Dresden, Germany.

2008 **Research Assistant. Prof. Jameel Khalifeh's group.**
University of Jordan, Amman, Jordan.
Worked on analytical evaluations of lattice Green's functions for isotropic and anisotropic FCC, BCC and SC lattices, where these are applied to evaluate resistance of networks of resistors.

2007 **DAAD Intern.**
Ilmenau Technical University, Ilmenau, Germany.
Developed a Mathematica™ visualization package to be used with an Ada implementation of a Kinetic Monte Carlo simulation of thin film growth package.

Teaching:

2009-2010 **Astronomy Laboratory Teaching Assistant, ASTR 263, ASTR 264.**
Purdue University, IN.

2008-2009 **Physics Laboratory Instructor.**
Middle East Technical University, North Cyprus Campus.
General Physics, Electromagnetism (PHYS 106).
General Physics, Classical Mechanics (PHYS 105).

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