BRUNO VILLASENOR

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GitHub: https://github.com/bvillasen Online CV: https://bvillasen.github.io/blog/cv/

EDUCATION

University of California, Santa Cruz *August 2016 - Expected Jun 2022*
Master of Science, Expected Ph.D. in Astronomy and Astrophysics
Department of Astronomy and Astrophysics. Advisor: Brant Robertson

Universidad Nacional Autonoma de Mexico, UNAM, Mexico *August 2010 - June 2016*
Bachelor of Science in Physics. Final Grade: 9.4 / 10
Thesis: "*On the kinematics of the stellar component of satellite galaxies as tracer of their dark matter distribution*", Advisor: Vladimir Avila-Resse

TECHNICAL SKILLS

Basic Knowledge	R, Matematica, Fortran
Intermediate Knowledge	Java, Matlab, HTML
Advanced Knowledge	Python, C/C++, CUDA, MPI, OpenMP, Julia

WORK EXPERIENCE

Summer Intern at Fermilab Fermi National Lab, Illinois, *Summer 2010*

- Fellow at the Internship for Physics Majors at Fermi National Accelerator Laboratory. Developed software to analyze events from the Tevatron collider and applied a new method to select Higgs Boson events from the WW decay, this algorithm was latter applied in the Higgs detection pipeline.
  Advisor: Eric James.

Summer Intern at Fermilab Fermi National Lab, Illinois, *Summer 2011*

- Received a "come back" offer for further development of the data analysis work done during the previous summer for the Higgs boson detection. Analyzed the Higgs Thrust from monte-carlo simulations and optimized the selection criteria for Higgs events from the Tevatron collider. Advisor: Eric James Sergo Jindariani

TEACHING EXPERIENCE

Teacher Assistant: **Intro. to Scientific Computing**, Astronomy Dept. UCSC. Winter 2016, Spring 2017

Teacher Assistant: **Computational Physics**, 7th semester, UNAM. Semester: 2016-1.

Teacher Assistant: **Electromagnetism I**,4th semester, UNAM. Semester: 2012-2.

Teacher Assistant: **Scientific Computing Using GPU's**,Advanced, UNAM. Semester: 2012-1.

Teacher Assistant: **Computation**, 1st semester, UNAM. Semesters: 2010-2, 2011-1, 2011-2, 2013-1.

MENTORING EXPERIENCE

Python Bootcamp Instructor for the Lamat 2020 Participants, UCSC:
Participated as the instructor for the 2020 Python Bootcamp. A one week long intensive program where the participants of the 2020 Lamat summer program learned the basics of scientific programming using Python so that they will be prepared for conducting scientific research in astrophysics during the summer.

Graduate Student Instructor for Introduction to Research (ASTR 9), UCSC:
Mentored a team of four first year undergraduate students through an astronomy research project that I designed. We ran and analyzed a set of dark matter cosmological simulations, located the dark matter halos and studied their density profile.

HONORS AND AWARDS

Excellence in Teaching: UCSC Astronomy Department Award Recipient, 2017.

Second place at the III Mexican Olympiad of Astronomy, INAOE, Mexico, 2007.

Participant at the XXXVII International Physics Olympiad, Iran, 2007.

Participant at the XXXVI International Physics Olympiad, Singapore, 2006.

Silver medal at the X Ibero-American Physics Olympiad, Uruguay, 2005.

First place at the XVI Mexican Physics Olympiad, Merida, Mexico, 2005.

Second place at the XV Mexican Physics Olympiad, Zacatecas, Mexico, 2004.

PUBLICATIIONS

B. Villaseor, R. Zamora-Zamora, D. Bernal, and V. Romero-Rochn, ”Quantum turbulence by vortex stirring in a spinor Bose-Einstein condensate”, 2014, Phys. Rev. A 89, 033611.

ADITIONAL EDUCATION

First Mexican AstroCosmoStatistics School, Guanajuato, Mexico, 2016

Sixth Mexican Summer School of Nuclear Physics, ICN, UNAM, Mexico, 2010.

Mexican delegate at the 2005 National Youth Science Camp, West Virginia, U.S. 2005.

Online Courses:

- Algorithms and Data Structures, Microsoft. (EdX).
- Learn to Program in Java, Microsoft. (EdX).
- Object Oriented Programming in Java, Microsoft. (EdX).
- Designing a Technical Solution, Microsoft. (EdX).
- Machine Learning, Coursera. (Stanford).
- Heterogeneous Parallel Programming, Coursera. (University of Illinois).
- Algorithms: Design and Analysis, Part 1, Coursera. (Stanford).
- Algorithms: Design and Analysis, Part 2, Coursera. (Stanford).
- Coding the Matrix: Linear Algebra through CS Applications, Coursera.
- Intro to Parallel programming, Udacity. (NVIDIA).
- Differential Equations in Action, Udacity.

PROFILE

I am computational astrophysicist with ample experience on high performance computing. For my Ph.D. I developed software to run cosmological simulations on the largest supercomputers of the world by exploiting the power of the GPUs on those systems. I have run large simulations in Summit producing hundreds of terabytes of data that now I am analysing for my thesis.

PROJECTS

For animations and images related to my projects, please visit my Online CV.

CHOLLA: Large Scale Cosmological Hydrodynamical Simulations on Multiple GPUs
Originally Cholla was a hydrodynamics solver that runs in multiple GPUs. For my Ph.D. thesis I have extended Cholla to run cosmological simulations, I added several physics modules:
- A distributed FFT based Poisson solver to include the self-gravity of the fluid.
- A Particle-Mesh scheme to solve the collisionless dynamics of the dark matter particles.
- Integration with Grackle, an open source library to solve the chemical network and track the ionization states of Hydrogen and Helium on the simulation. Also include a uniform time-dependent UV background to account for the reionization of the universe.

Cholla uses MPI, CUDA and OpenMP to leverage the computing power of the largest computers in the world. I have used Cholla to run cosmological simulations in Summit (ORNL, number one in the top500) where I measured the performance of the code obtaining near perfect scaling when used in up to 16,000 GPUs.

Inferring the Dark Matter Density Profiles of Satellite Galaxies from the Stellar Kinematics
For my undergraduate thesis, I analyzed a high resolution simulation of a system of galaxies similar to the local group, where the main galaxy had characteristics and dynamical properties similar to the Milky-Way (mass, rotational velocity, thickness of the disk, etc.). My work consisted of measuring the dynamical properties of the stars in the satellite galaxies and from those measurements I used Monte Carlo Markov Chains (MCMCs) to fit models to the density profiles of the dark matter halos that hosted those satellite galaxies. Then I compared the estimated density profiles to the real halo density profiles that I measured directly from the dark matter particles in the simulation, this allowed me to compare the results of statistical methods used in astronomy to estimate the dark matter profile of the halos from observed satellite galaxies to the actual profile in the simulation and evaluate how accurate are the estimates from observations. In particular I focused on the the density at the most inner part of the halos where currently there is a discrepancy between the theory and the observations, this is known as the Core-Cusp problem.

Turbulence in Bose-Einstein Condensates
Using pyCUDA I developed software to solve the evolution of a Bose-Einstein condensate, which is a gas cooled to temperatures near the absolute zero (-217 C), at this extreme temperature the gas becomes a super-fluid which means that the fluid has zero viscosity.

From the data obtained from simulations I studied the properties of the turbulent motion of the gas and compared to known properties of turbulence in regular fluids, in particular I showed that the energy power spectrum on the quantum fluid scales as the well known Kolmogorov relation for turbulence in viscous fluids. This work resulted in the following publication where we propose a mechanism for developing a turbulent flow in a Bose-Einstein Condensate.

Volume Render
I believe that visualization plays a very important role in understanding the physical phenomena that we study by using computers to numerically solve the equations that govern their evolution, this motivated me to apply my knowledge of GPU computing and visualization to develop a 3D volume render that I could use to visualize the physics that I was solving. For this project I used pyCUDA to call CUDA kernels from python and run a ray-tracing algorithm over some volumetric data, then I used pyOpenGL to display the generated image and to record mouse or keyboard events, this allowed the user to interact with the simulation in real time.