MICHIGAN STATE UNIVERSITY

Towards a more diverse and equitable physics graduate program

Danny Caballero (he/they)

Department of Physics and Astronomy Department of Computational Mathematics, Science, and Engineering CREATE For STEM Institute



In summary...

Rest stops WYOMING Boulder O COLORADO Albuquerque NEW MEXICO son Ciudad Juárez

ONORA CHIHUAHUA

A SUR SINALOA DURA



Interested in understanding how the physical world works

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- Developing the knowledge and skills to pursue scientific interests

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- Finding a career in science, science education, science policy, etc And many more (and some very personal) reasons...

There are nearly 200 programs in the US granting PhDs in physics.

Number of Degree-granting Physics Departments.



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http://www.aip.org/statistics
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Number of Departments



*Includes three departments that conferred one PhD during the 3-year period, classes of 2010, 2011 & 2012 combined.

http://www.aip.org/statistics

28 30+ 26



Number of Departments



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Average Number of PhDs Conferred

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Note: Employment in physics means an individual's primary or secondary employment field was in physics or astronomy. Data includes only US-educated PhDs who remained in the US after earning their degrees.

AIP American Institute of Physics





~33% of PhD graduates are not working in physics

~40% are working in the same subfield of physics



Employment Field of New Physics PhDs, Classes of 2015 & 2016 Combined



Note: Employment in physics means an individual's primary or secondary employment field was in physics or astronomy. Data includes only US-educated PhDs who remained in the US after earning their degrees.

AIP American Institute of Physics





A wide variety of technical and interpersonal skills are used by employed PhD graduates

Interpersonal and Management Skills Used by New Physics PhDs Holding Postdocs and Potentially Permanent Positions in Academia, Classes of 2015 & 2016 Combined



Percentages represent the proportion of physics PhDs who chose "daily," "weekly," or "monthly" on a four-point scale that also included "never or rarely." Data only include US-educated PhDs who remained in the US after earning their degrees. Academia refers to physics PhDs holding potentially permanent positions in two- and four-year colleges or universities and university affiliated research institutes. Figure based on 380 postdocs and 52 potentially permanently emplyoyed PhDs in academia.

AIP Statistics



• An accomplishment



- An accomplishment
- A "ticket to do research"



- An accomplishment
- A "ticket to do research"
- A credential for future employment



- An accomplishment
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- A credential for future employment
- A societal marker



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- A societal marker



But earning a PhD is not the only marker for success!

Percent of PhDs Earned by Women in Selected Fields, Classes of 1981 through 2016



Source: National Science Foundation, National Center for Science and Engineering Statistics. Data compiled by AIP Statistical Research Center.

AIP Statistics

aip.org/statistics

- Biological Science
- -Chemistry
- -Mathematics
- -Engineering
- -Computer Science

About 20% of PhDs in physics are granted to women

More women are earning PhDs in physics (and in STEM)





Few PhDs are granted to African-American (~14% of US pop) or to Hispanic-Americans (~20% of US pop)

Number

AIP Statistics

Number of Physics Doctorates Earned by African-Americans and Hispanic-Americans, Classes 1996 through 2017.



Classes of (2-Year Average)



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Increase the proportion of underrepresented folks in graduate physics programs and support their transition to professional careers

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Create structures and programs that remove barriers and promote full participation

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> Reshape the culture of physics to bring traditionally excluded folks into critical activities and decision making



Increase the proportion of underrepresented folks in graduate physics programs and support their transition to professional careers

Create structures and programs that remove barriers and promote full participation

Sustain these changes over the long term

Reshape the culture of physics to bring traditionally excluded folks into critical activities and decision making





Summarized from UC Berkeley Division of Equity and Inclusion (<u>https://diversity.berkeley.edu/</u>)


status, ability status, and veteran status.

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• **Diversity** - The different identities people hold at the same time. Among a variety of identities includes race, ethnicity, gender expression, socioeconomic

"DEI"

- status, ability status, and veteran status.
- Equity The guarantee of fair treatment, access, opportunity, and advancement. Striving to identify and eliminate barriers preventing full participation.

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- status, ability status, and veteran status.
- Equity The guarantee of fair treatment, access, opportunity, and advancement. Striving to identify and eliminate barriers preventing full participation.
- Inclusion Authentically bringing in traditionally-excluded individuals into opportunities and resources.

Summarized from UC Berkeley Division of Equity and Inclusion (<u>https://diversity.berkeley.edu/</u>)

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activities and decision making. Sharing power and ensuring equal access to

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- Equity Changing admissions criteria to remove barriers for applicants; Creating structures that support the transition to graduate physics programs (e.g., the APS Bridge Program)
- Inclusion Creating a governance structure where graduate students participate in and vote on departmental decisions; Implementing a departmental code of conduct and the associated accountability practices

Informal/Anecdotal: What we hear from folks; what we remember from history; can be subject to biases and centering one's own perspectives

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Mixed Methods Research: A research tradition that blends Qualitative and Quantitative approaches to generate complementary evidence

STEM Education Research

- Studies by STEM professionals of:
 - how students understand STEM (concepts, practice, identity)
 - curricula / pedagogy
 - tools / context
- Theory, experiment, and applied







learningmachineslab.github.io github.com/learningmachineslab





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learningmachineslab.github.io github.com/learningmachineslab

The Learning Machines Lab focuses on generating quantitative evidence for understanding issues in STEM Education.









A Graduate Program in Physics



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Graduate Students

A Graduate Program in Physics



Graduate Students

A Graduate Program in Physics

PhD Graduates



Graduate Students

A Graduate Program in Physics

PhD Graduates



Applicants

Graduate Students

A Graduate Program in Physics

PhD Graduates



Applicants Admissions



A Graduate Program in Physics

Graduate Students

PhD Graduates



Applicants Admissions

Learning

A Graduate Program in Physics

Graduate Students

Mentoring

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Placement Employed Graduates



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Graduate Students

Courses Candidacy Research

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PhD Graduates

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Applicants Admissions

Learning

A Graduate Program in Physics

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Courses Candidacy Research

"Graduate School"

Mentoring

PhD Graduates

Placement Employed Graduates



Applicants Admissions



Focus for Today

Holistic **Rubric-Based** Admissions

Graduate Students



Admissions Package

GRE scores

GPA

Personal statement

Research statement

Letters of

recommendation



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Faculty consider most parts of the application important.



Potvin, Chari, and Hodapp, Phys. Rev. PER, 2017

GRE quantitative **GRE** verbal **GRE** written

GRE physics subject

TOEFL

Letters of recommendation

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Recommenders' rankings

Quality of interviews

Proximinty/familiarity

Personal statements

Prior research experiences

Prior publications

Prior conference presentations

Student research interests

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Moderately Important

Faculty consider most parts of the application important.



Potvin, Chari, and Hodapp, Phys. Rev. PER, 2017

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Above average importance

Some parts are more important



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INSIDE GRADUATE ADMISSIONS MERIT, DIVERSITY, AND FACULTY GATEKEEPING

JULIE R. POSSELT



In-depth research into admissions deliberations



GRE General Test ~4 hour test in three parts Cost: \$205

Perspective (12% income tax): \$7.25/hr -> \$6.38/hr (56 hrs) \$2.13/hr -> \$1.87/hr (190 hrs)

GRE Subject Test (Physics) ~3 hour, 100 question, multiple-choice Cost: \$150

GRE General Test ~4 hour test in three parts Cost: \$205

- 41. The quantum efficiency of a photon detector is 0.1. If 100 photons are sent into the detector, one after the other, the detector will detect photons
 - (A) exactly 10 times
 - (B) an average of 10 times, with an rms deviation of about 0.1
 - (C) an average of 10 times, with an rms deviation of about 1
 - (D) an average of 10 times, with an rms deviation of about 2
 - (E) an average of 10 times, with an rms deviation of about 3

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 - an average of 10 times, with an rms deviation of about 3 (E)

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(A)
$$c\cos\theta$$

(B)
$$c \exp\left(-\frac{r}{a_0}\right)$$

(C) $c\left(1-\frac{r}{2a_0}\right)\exp\left(-\frac{r}{2a_0}\right)$
(D) $c\left(1-\frac{r}{2a_0}\right)\exp\left(-\frac{r}{2a_0}\right)\cos\theta$
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- 53. A microwave line has a laboratory wavelength of l µm. If the Hubble constant $H \approx 75$ (km/s)/Mpc, the observed wavelength for the line from a galaxy 100 Mpc distant is about
 - (A) 250 nm shorter
 - 25 nm shorter (\mathbf{B})
 - (C) the same
 - 25 nm longer (D)
 - 250 nm longer (E)



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NOTE: many students will not have taken upper-level physics courses before taking the PGRE





This distribution of GRE scores suggests weighting scores in admissions limits the diversity of potential PhD students [1].

[1] Miller et al., Sci. Adv. 2019;5:eaat7550
[2] G. L. Cochran, et al, 2018 PERC Proceedings
[3] R. Wilson, PhD Dissertation (2020)



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0.6 completion probability 0.4 0.2 0.0 1.0⊢ 0.8 PHD 0.6 0.4 0.2

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These numerical markers, GRE and UGPA, are not predictors of PhD completion [1].





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Students are aware of the bias in the GRE and some see it as a barrier to even applying [2,3].

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Reminder: PhD completion should not be our only marker of success



Distribution of NBA player heights (last 10 years)



Height of player

https://www.thehoopsgeek.com/average-nba-height/

Percentage of players

Distribution of NBA player heights (last 10 years)



Height of player

https://www.thehoopsgeek.com/average-nba-height/



Mr. Bol (7'7") and Mr. Bogues (5'3")













"The GRE helps students stand out"

What Are the Subject Tests?

[4]

The GRE® Subject Tests are achievement tests that measure your knowledge of a particular field of study.

Show what you know about a specific subject and graduate schools will take notice. The Subject Tests can help you stand out from other applicants by emphasizing your knowledge and skill level in a specific area.

> [4] <u>https://www.ets.org/gre/subject/about</u> [5] Young & Caballero, Phys. Rev. PER, 2021



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"...scoring highly on the physics GRE does not help applicants from small or less selective schools or applicants with a low GPA 'stand out'." [5]

Fraction of admitted students by PGRE score and GPA



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Fraction of admitted students by PGRE score and GPA



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[5] Young & Caballero, Phys. Rev. PER, 2021

GRE cutoffs favor high GPAs, large schools, and men^[6]



[6] Mikkelsen, Young, and Caballero, Phys. Rev. PER, 2021





Michigan State as a Case for Change

Physics and Astronomy



Michigan State as a Case for Change

Physics and Astronomy



Michigan State as a Case for Change

MSU Physics and Astronomy is a large, high research activity program.

Physics and Astronomy



Admissions Process (Pre 2018)

- Applicants submitted transcripts, GRE scores, statements, letters
- Spreadsheets organized applicant materials and a large (10+) committee reviewed applicants
- Soft cut-offs for GRE were used

Michigan banned Affirmative Action programs by ballot initiative in 2006.

The University of Michigan, Michigan State University, Wayne State University, and any other public college or university, community college, or school district **shall not discriminate against, or grant preferential treatment to**, any individual or group on the basis of race, sex, color, ethnicity, or national origin in the operation of public employment, public education, or public contracting.

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Admitted Student Population

Women

Racial/Ethnic Minorities

Fall 2016 and before	Not Re	ecorded
Fall 2017	5%	13%

Can predict ~80% of admitted students with PGRE and UGPA^[7]

Importance of factors for being admitted to a Physics PhD program

[7] Young and Caballero, 2018 PERC Proceedings

Changes to Process

[8] Posselt, Inside Graduate Admissions, Harvard University Press, 2016[9] IGEN; pullias.usc.edu/igen/

Changes to Process

• Fall 2017

- Julie Posselt (USC) delivers Colloquium
- With Casey Miller (RIT), JP runs workshop on Graduate Admissions Rubrics [8,9]
- Graduate Program Committee develops initial rubric

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JULIE R. POSSELT

Changes to Process

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- Spring 2018
 - First class of students admitted using rubric

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item subitem		High	Medium	Low
		GPA>=3.7 (A-) in all core subjects:	GPA >=3.3 (B+) in all core:	
		CM1&2, EM1&2, QM1&2, SM1, if	CM1&2, EM1&2, QM1&2, SM1;	GPA>=3.7 (A-) in EM1 and CM1;
		not taken 2nd semester courses	OR GPA>=3.7 (A-) in CM1, EM1,	GPA>=3.0 (B) average in other
		yet are they planning on taking	QM1, SM1 if no 2nd semester	advanced courses; any grades
Academic Preparation (25%)	Physics Coursework	them?	courses taken	<2.7 (B-) without explanation
			DiffEq, Linear, and a Math	
			Methods course, all with >=3.5 (A)	Bare bones math prep (e.g., up to
		Real and Complex Analysis, Group	grades; or more than this with	DiffEq), or low grades regularly on
	Math Coursework	Theory with GPA>=3.5 (A) grades	GPA>=3.0 (B or A) grades	math
			Consistently 2.0 (P) grades with	
	Other Coursework	Consistently 2.5 (A) grades	Consistently 5.0 (B) grades with	One or more $2 E_2 (P_1(C_1))$
	Other Coursework	Consistently 3.5 (A) grades	nothing below a 2.5 (B-/C+)	
	Acadomic honors and/or	muluple nonors, e.g.,		No coodomic honoro in collogo
	Academic nonors and/or	Kappa eta	one geodemic sword/resegnition	No academic honors in college
	recognitions	Rappa, etc	one academic awaru/recognition	nothing more then coursework
Pessarch (25%)	variety/duration	two years in research	one year in research: only PEUs	Information coursework
Tresearch (2076)	valiety/duration		one year in research, only rccos	limited intellectual or technical
			clearly made significant	contribution to projects: "button
	quality of work	multiple indications of excellence	contributions to the project	nusher"
	quality of work	a variety of experiment theory	has developed only one class of	nothing more than coursework
	technical skills	and/or computational skills	skill (exp or theory or comp)	laboratories
		clear commitment to and	clear commitment to and	
		enthusiasm for research: AND	enthusiasm for research: OR	not clear if they know what they
		understands what the process	understands what the process	are getting into with a PhD: seems
	dispositions	entails	entails	lukewarm about research
		Consistently strives to improve or	Has demonstrated a high	No evidence of striving for
Non-Cognitive Competencies		meet a high standard of excellence	standard of excellence in selected	excellence provided in application
(25%)	Achievement Orientation	in all areas	areas	or student record
		Takes responsibility for personal	Takes responsibility for personal	No evidence of taking
		performance, both the good and	performance, both the good and	responsibility for performance
		the bad; AND demonstrates	the bad; OR demonstrates	AND minimal evidence of efficient,
	Conscientiousness	efficiency and organization	efficiency and organization	organized work
				Has not sought out or taken
				advantage of opportunities AND
		Consistently seeks out or acts on	Consistently seeks out or acts on	does not have a record of
	Initiative	opportunities AND takes leadership	opportunities OR takes leadership	leadership
		Application clearly describes		
		successful coping with failures/	Basic or perfunctory description of	Application does not describe
	Perserverence	obstacles	overcoming challenges	experience with failure/obstacles

	item		subitem		High		Medium		Low	
ite	m		subitem		High		Medium		l	Low
Academic Prep	Academic Preparation (25%)		ysics Coursework	GP. CN nc	A>=3.7 (A-) in all core subject A1&2, EM1&2, QM1&2, SM ot taken 2nd semester cours ret are they planning on takin them?	ects: 1, if ses ng	GPA >=3.3 (B+) in a CM1&2, EM1&2, QM1 OR GPA>=3.7 (A-) in (QM1, SM1 if no 2nd a courses take	all core: I&2, SM1; CM1, EM1, semester n	GPA>=3.7 (A-) GPA>=3.0 (B) advanced cou <2.7 (B-) with	in EM1 a average irses; any hout expla
		M	lath Coursework	Rea The	al and Complex Analysis, Gr eory with GPA>=3.5 (A) gra	DiffEq, Linear, and a Methods course, all with alysis, Group grades; or more than t GPA>=3.0 (B or A) g		a Math h >=3.5 (A) this with grades	Bare bones ma DiffEq), or low g n	th prep (e grades reg nath
			Academic honors and/or recognitions		Dept/University Honors; Phi Beta Kappa, etc	one	e academic award/recognition	No academic documented	c honors in college d in the application	
	Research ((25%)	variety/duration		two years in research	one	e year in research; only REUs	nothing mor lab	e than coursework oratories	
			quality of work		multiple indications of excellence	c	clearly made significant contributions to the project	limited intell contribution	ectual or technical to projects; "button busher"	
			technical skills		a variety of experiment, theory, and/or computational skills	has sl	developed only one class of kill (exp or theory or comp)	nothing mor lab	e than coursework oratories	
			dispositions		clear commitment to and enthusiasm for research; AND understands what the process entails	er un	clear commitment to and nthusiasm for research; OR iderstands what the process entails	not clear if th are getting into lukewarm	ey know what they o with a PhD; seems about research	
	Non-Cognitive Co (25%)	ompetencies	Achievement Orientation	n	Consistently strives to improve or neet a high standard of excellence in all areas	stan	Has demonstrated a high dard of excellence in selected areas	No eviden excellence pro or stu	ce of striving for ovided in application ident record	
			Conscientiousness		Takes responsibility for personal performance, both the good and the bad; AND demonstrates efficiency and organization	Tak per t	tes responsibility for personal formance, both the good and the bad; OR demonstrates efficiency and organization	No evid responsibilit AND minimal orga	ence of taking ty for performance evidence of efficient, nized work	
			Initiative	c	Consistently seeks out or acts on opportunities AND takes leadership	Con	nsistently seeks out or acts on ortunities OR takes leadership	Has not so advantage of does not lea	ught out or taken opportunities AND have a record of adership	
			Perserverence		Application clearly describes successful coping with failures/ obstacles	Basi	ic or perfunctory description of overcoming challenges	Application experience w	does not describe ith failure/obstacles	

item			subitem	High		Medium	Low			
	ite	m		subitem	High		Medium		L	ow
	Academic Prep	paration (25%)	Ph	ysics Coursework	GPA>=3.7 (A-) in all core subject CM1&2, EM1&2, QM1&2, SM2 not taken 2nd semester cours yet are they planning on takin them?	ects: 1, if ses ng	GPA >=3.3 (B+) in a CM1&2, EM1&2, QM1 OR GPA>=3.7 (A-) in (QM1, SM1 if no 2nd s courses take	all core: &2, SM1; CM1, EM1, semester n	GPA>=3.7 (A-) i GPA>=3.0 (B) i advanced cour <2.7 (B-) with	in EM1 a average ses; any out expla
			N	lath Coursework	Real and Complex Analysis, Gr Theory with GPA>=3.5 (A) gra	roup des	DiffEq, Linear, and Methods course, all wit grades; or more than GPA>=3.0 (B or A)	a Math h >=3.5 (A) this with grades	Bare bones matl DiffEq), or low gr m	h prep (e rades reg ath
				Academic honors and/or recognitions	Dept/University Honors; Phi Beta Kappa, etc	one	e academic award/recognition	No academic documented nothing mor	c honors in college d in the application e than coursework	
	Researc	h (25%)		variety/duration	two years in research		one year in research;	only REUs	nothing more f labor	than cour atories
				quality of work	multiple indications of exceller	nce	clearly made sign contributions to the	ificant project	contribution to	ctual or te projects; sher"
				dispositions	clear commitment to and enthusiasm for research; AND understands what the process entails Consistently strives to improve or	er	clear commitment to and nthusiasm for research; OR derstands what the process entails Has demonstrated a high	not clear if th are getting into lukewarm No eviden	ney know what they o with a PhD; seems about research nce of striving for	
		Non-Cognitive Cor (25%)	npetencies	Achievement Orientation	meet a high standard of excellence in all areas Takes responsibility for personal	stand Take	dard of excellence in selected areas tes responsibility for personal	excellence pro or stu No evid	ovided in application Ident record ence of taking	
				Conscientiousness	performance, both the good and the bad; AND demonstrates efficiency and organization	perf tl e	formance, both the good and the bad; OR demonstrates efficiency and organization	responsibili AND minimal orga	ty for performance evidence of efficient, inized work	
				Initiative	Consistently seeks out or acts on opportunities AND takes leadership	Con	sistently seeks out or acts on ortunities OR takes leadership	Has not so advantage of does not lea	ought out or taken f opportunities AND have a record of adership	
				Perserverence	Application clearly describes successful coping with failures/ obstacles	Basic	c or perfunctory description of overcoming challenges	Application experience w	does not describe /ith failure/obstacles	

		item		subitem	High		Medium		Low	
item			subitem	High		Medium		Lo	W	
				GPA>=3.7 (A-) in all core subje	ects:	GPA >=3.3 (B+) in a	all core:			
					CM1&2, EM1&2, QM1&2, SM1	1, if	CM1&2, EM1&2, QM1	I&2, SM1;	GPA>=3.7 (A-) ii	n EM1 a
					not taken 2nd semester cours	es	OR GPA>=3.7 (A-) in (CM1, EM1,	GPA>=3.0 (B) a	average
					yet are they planning on takir	ו g	QM1, SM1 if no 2nd	semester	advanced cours	ses; any
	Academic Prep	aration (25%)	Pr	ysics Coursework	them?		courses take	n	<2.7 (B-) with	out expla
							DiffEq, Linear, and	a Math		
							Methods course, all wit	h >=3.5 (A)	Bare bones math	ı prep (e
					Real and Complex Analysis, Gr	oup	grades; or more than	this with	DiffEq), or low gra	ades reg
			N	Aath Coursework	Theory with GPA>=3.5 (A) grad	des	GPA>=3.0 (B or A)	grades	ma	ath
				Academic honors and/or	Dept/University Honors; Phi Beta			No academic	honors in college	
				recognitions	Kappa, etc	one	academic award/recognition	documented	in the application	
						_			nothing more t	han coui
	Researc	h (25%)		variety/duration	two years in research		one year in research;	only REUs	labora	atories
									limited intellect	tual or te
							clearly made sign	ificant	contribution to	projects;
				quality of work	multiple indications of exceller	nce	contributions to the	project	pus	sher"
					clear commitment to and	(clear commitment to and	not also rif th	au know what they	
					understands what the process		derstands what the process	are getting into	with a PhD; seems	
Г					Consistently strives to improv	e or	Has demonstrate	d a high	No evidence	e of strivi
	Non-Cognitive	Competencies			meet a high standard of excelle	ence	standard of excellence	in selected	excellence provi	ided in a
	(25	5%)	Ach	ievement Orientation	in all areas		areas		or stude	ent recor
					Takes responsibility for perso	nal	Takes responsibility for	or personal	No eviden	ice of tal
					performance, both the good a	and	performance, both the	e good and	responsibility	for perfo
					the bad; AND demonstrate	S	the bad; OR demo	nstrates	AND minimal ev	idence o
				Conscientiousness	efficiency and organization	า	efficiency and orga	anization	organi	zed work
					Consistently seeks out or acts on	Con	sistently seeks out or esta on	advantage of	opportunities AND	
				Initiative	opportunities AND takes leadership	oppo	ortunities OR takes leadership	lea	adership	
					Application clearly describes					
				D	successful coping with failures/	Basic	c or perfunctory description of	Application	does not describe	
				Perserverence	obstacles		overcoming challenges	experience w	in failure/obstacles	

		research interests align with	research interests align with	limited alignment between
Fit with program (15%)	research	multiple faculty in multiple subfields	multiple faculty in one subfield	interests and faculty exp
		someone wants to hire as RA now	someone could supervise, but	
		and/or there is a clear fit with	interests do not directly support a	faculty aligned with appli
	faculty	current faculty expertise	faculty member's work	interests are not seeking s
		has clearly contributed positively to		applicant only discuss
		prior department/school culture,		him/herself; no evidenc
		and would do the same for our	some evidence of participating in	engagement in departme
	community	program	service activities	university activities
			belongs to an underrepresented	
			identity group; first generation in	
			college or low SES; and/or	
		applicant has been an active	contributes to another type of	contributions to diversity
	diversity	advocate for diversity in physics	diversity the department seeks	unclear from the applica
		Verbal(V) and Quantative(Q)		
		scores >=75% (or 157 for V and	V & Q scores >=75% (or 157 for	
GRE Scores (10%)	General GRE	160 for Q) AND Analytical	V and 160 for Q) BUT AW<4.0	v or Q score <75% and A
		Writing (AW) >=4.0		
	Physics GRE	>=75%	50-74%	<49%

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	community	program	service activities	university activities
		applicant has been an active	belongs to an underrepresented identity group; first generation in college or low SES; and/or contributes to another type of	contributions to diversity
	diversity	advocate for diversity in physics	diversity the department seeks	unclear from the applic
GRE Scores (10%)	General GRE	Verbal(V) and Quantative(Q) scores >=75% (or 157 for V and 160 for Q) AND Analytical Writing (AW) >=4.0	V & Q scores >=75% (or 157 for V and 160 for Q) BUT AW<4.0	V or Q score <75% and A
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research	multiple faculty in multiple subfields	multiple faculty in one subfield	interests and faculty ex
	someone wants to hire as RA now	someone could supervise, but	
	and/or there is a clear fit with	interests do not directly support a	faculty aligned with app
faculty	current faculty expertise	faculty member's work	interests are not seeking
	has clearly contributed positively to		applicant only discus
	prior department/school culture,		him/herself; no evider
	and would do the same for our	some evidence of participating in	engagement in departr
community	program	service activities	university activitie
		action of low SES: and/or	
	applicant has been an active	contributes to another type of	contributions to diversity
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	Writing (AW) >=4.0		
Physics GRE	>=75%	50-74%	<49%
	research faculty community diversity General GRE	research research interests align with multiple faculty in multiple subfields someone wants to hire as RA now and/or there is a clear fit with current faculty expertise someone wants to hire as RA now and/or there is a clear fit with current faculty expertise faculty has clearly contributed positively to prior department/school culture, and would do the same for our program community program diversity applicant has been an active advocate for diversity in physics General GRE Verbal(V) and Quantative(Q) scores >=75% (or 157 for V and 160 for Q) AND Analytical Writing (AW) >=4.0 Physics GRE >=75%	research research interests align with multiple faculty in multiple subfields research interests align with multiple faculty in one subfield faculty someone wants to hire as RA now and/or there is a clear fit with current faculty expertise someone could supervise, but interests do not directly support a faculty member's work has clearly contributed positively to prior department/school culture, and would do the same for our program some evidence of participating in service activities diversity applicant has been an active advocate for diversity in physics identity group, mist generation misters to another type of diversity the department seeks General GRE Verbal(V) and Quantative(Q) scores >=75% (or 157 for V and 160 for Q) AND Analytical Writing (AW) >=4.0 V & Q scores >=75% (or 157 for V and 160 for Q) BUT AW<4.0

Fit with program (15%)	research	research interests align with multiple faculty in multiple subfields	research interests align with multiple faculty in one subfield	limited alignment betwee interests and faculty ex
	faculty	someone wants to hire as RA now and/or there is a clear fit with current faculty expertise	someone could supervise, but interests do not directly support a faculty member's work	faculty aligned with app interests are not seeking
	community	has clearly contributed positively to prior department/school culture, and would do the same for our program	some evidence of participating in service activities	applicant only discus him/herself; no evider engagement in departr university activitie
	diversity	applicant has been an active advocate for diversity in physics	college or low SES; and/or contributes to another type of diversity the department seeks	contributions to diversity unclear from the applica
GRE Scores (10%)	General GRE	Verbal(V) and Quantative(Q) Verbal(V) and Quantative(Q) scores >=75% (or 157 for V and 160 for Q) AND Analytical Writing (AW) >=4.0	V & Q scores >=75% (or 157 for V and 160 for Q) BUT AW<4.0	V or Q score <75% and
	Physics GRE	>=75%	50-74%	<49%

		All Rated	Applicants ((N=321)
nic tion	Physics Coursework-	•		•
der ara	Math Coursework-	0		
Aca	All Other Coursework-		•	-
	Academic Honors-	•	0	•
÷	Variety/Duration of Research-	0	•	•
aro	Quality of work-	0	•	•
ese	Technical Skills-	0	•	•
£	Research Dispositions-	0	•	•
ive	Achievement Orientation -	0		
gnit enc	Conscientiousness-	0	•	•
bet -c	Initiative-	0	•	•
Non com	Perseverance-	0	•	•
_	Alignment of Research-	0		
vith ram	Alignment with Faculty-	0	•	•
Fit v rogi	Community contributions -	0	•	•
шă	Diversity contributions -	•	•	•
ŝ				
core	General GRE Scores-	0	•	•
ы С				
GR	Physics GRE Score-			
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			14	

Young, Tollefson, Zegers, and Caballero, Phys. Rev. PER, 2022

		All Rated	Applicants (N=321)
Academic Preparation	Physics Coursework Math Coursework All Other Coursework Academic Honors		
Research	Variety/Duration of Research Quality of work Technical Skills Research Dispositions	- 0 - 0 - 0	
Non-cognitive competencies	Achievement Orientation Conscientiousness Initiative Perseverance	0 0 0	
Fit with program	Alignment of Research Alignment with Faculty Community contributions Diversity contributions		
GRE scores	General GRE Scores	•	
		Low	Medium High

Some criteria have ratings across rubric levels

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		All Rated Applicants (N=321					
	Academic Preparation	Physics Coursework - Math Coursework - All Other Coursework - Academic Honors -					
	Research	Variety/Duration of Research - Quality of work - Technical Skills - Research Dispositions -	0 0 0				
	Non-cognitive competencies	Achievement Orientation - Conscientiousness - Initiative - Perseverance -	0				
	Fit with program	Alignment of Research - Alignment with Faculty - Community contributions - Diversity contributions -	•				
	cores	General GRE Scores-	0	•	•		
	GRE s	Physics GRE Score-	Low	dium	High		
				No			





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Admitted applicants score "high"; rejected applicants score "medium"



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Only differences in ratings between male & female identified applicants Physics GRE scores and service/diversity contributions.



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Academic Preparation (25%)
 - coursework; grades; honors

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 coursework; grades; honors
- Research (25%)
 experience; quality of work; skills

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 contentiousness; initiative; perseveration
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 research field; group needs; advocac
- GRE Scores (10%)

Admitted Student Population

		Women	Racial/Eth
	Fall 2018	27%	12%
	Fall 2019	20%	21%
	Fall 2020	15%	18%
ance	Fall 2021	35%	20%
	Fall 2022	28%	18%
y for diversity			



- Academic Preparation (25%)
 coursework; grades; honors
- Research (25%)
 experience; quality of work; skills
- Non-cognitive Competencies (25%)
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Admitted Student Population

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	Fall 2019	20%	21%
	Fall 2020	15%	18%
ance	Fall 2021	35%	20%
	Fall 2022	28%	18%
y for diversity	Reminder		
	Fall 2017	5%	13%



Recruiting

Applicants Admissions



Focus for Today

Holistic **Rubric-Based** Admissions

Graduate Students



Recruiting

Applicants Admissions

Learning

A Graduate Program in Physics

Graduate Students

Courses Candidacy Research

Mentoring

PhD Graduates

Placement Employed Graduates



There's lots of work to do

- First year experience is being retooled; focus on transition to graduate school Pathways to PhD candidacy requires reflecting on goals and offering
- alternatives
- We must address systemic sexism[10] and racism throughout our program MSU joined the APS Inclusion, Diversity, and Equity Alliance (APS-IDEA)

[10] Aycock et al, PRPER 15, 010121 (2019)



- Provide more flexible pathways to complete course work
 - Reduced number of required courses

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- Candidacy requirements deemphasize exams •
 - Can earn good grades in courses or subject exams (per course choice)

- Provide more flexible pathways to complete course work
 - Reduced number of required courses
- Candidacy requirements deemphasize exams
 - Can earn good grades in courses or subject exams (per course choice)
- Shifting graduate instructional culture
 - Subject exam committees design and grade exams collaboratively
 - Grad course help desk for all first year courses
 - Grad course instructors use evidenced-supported group work activities

And they don't predict completion of PhD programs

• Traditional metrics for admissions do not align with diversity goals [1,2,3]

- Traditional metrics for admissions do not align with diversity goals [1,2,3] And they don't predict completion of PhD programs • The GRE does not help students standout [4,5] • And cutoffs (even soft ones) are problematic [6,7]

- - And they don't predict completion of PhD programs
- The GRE does not help students standout [4,5]
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- Admissions rubrics codify what we value, and can help increase diversity [8,9]

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- - And they don't predict completion of PhD programs
- The GRE does not help students standout [4,5]
 - And cutoffs (even soft ones) are problematic [6,7]
- Admissions rubrics codify what we value, and can help increase diversity [8,9]
- There's still lots of work to do (re: equity and inclusivity)

• Traditional metrics for admissions do not align with diversity goals [1,2,3]

Thank you!

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learningmachineslab.github.io github.com/learningmachineslab

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