Course Change Request

New Course Proposal

Date Submitted: 04/23/18 6:46 pm

Viewing: ASTR 620 : Exoplanets

Last edit: 04/23/18 6:46 pm

Changes proposed by: jweinga1

In Workflow

1. **PHYS GR Committee**
2. **PHYS Chair**
3. **SC Curriculum Committee**
4. SC Associate Dean
5. Assoc Provost-Graduate
6. Registrar-Courses
7. Banner

Approval Path

1. 04/25/18 11:53 am Robert Weigel (rweigel): Approved for PHYS GR Committee
2. 04/25/18 12:01 pm Paul So (paso): Approved for PHYS Chair

Are you completing this form on someone else's behalf?

Yes

Requestor:

Name	Extension	Email
Peter Plavchan	5893	pplavcha@gmu.edu

Effective Term: Fall 2018

Subject Code: ASTR - Astronomy **Course Number:** 620

Bundled Courses:

Equivalent Courses:

Catalog Title: Exoplanets

Banner Title: Exoplanets

Will section titles vary by semester? No

Credits: 3

Schedule Type: Lecture

Hours of Lecture or Seminar per week: 3

Repeatable: May only be taken once for credit (NR)

Default Grade Mode: Graduate Regular

Recommended Prerequisite(s):

Recommended Corequisite(s):

Required Prerequisite(s) / Corequisite(s) (Updates only):

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?

Registration Restrictions (Updates only):

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Level(s):

Degree(s):

School(s):

Catalog Description: Survey of exoplanet science. Topics include techniques for detecting and characterizing exoplanets, including their composition, atmospheres, and demographics.

Justification: This course covers a major area of modern astronomy that has so far been missing from our curriculum.

Does this course cover material which crosses into another department?	No
Learning Outcomes:	
Attach Syllabus (PDFs only)	ASTR620-syllabus.pdf
Additional Attachments (PDFs only)	
Staffing:	Peter Plavchan
Relationship to Existing Programs:	Will be an elective course for PhD in physics
Relationship to Existing Courses:	None

Additional Comments:

Reviewer Comments

Key: 15774

ASTR 620 - Exoplanets – Syllabus

Lecture: TuTh 1:30pm-2:45pm, Innovation Hall 323

Instructor: Dr. Peter Plavchan

Cell: (626) 234-1628
Office: Planetary 243
Email: pplavcha@gmu.edu

Office Hours: Mon-Fri 4-5pm

Materials:

Required (grad): The Exoplanet Handbook by Perryman

Required (grad): Exoplanets by Seager

Required (grad): Exoplanet Atmospheres by Seager

Reference (grad): How Do You Find an Exoplanet by Johnson (required for undergraduates)

Exams: Midterm, Final

Homework: There will be homeworks, exams and an individual project, covering material from the class.

Grading Policy:

Homeworks	50%
Project Paper	10%
Project Presentation	10%
Midterm	10%
Final	20%

A curve will be applied.

Grade determined as follows:

90-100 – A 80-89 – B 70-79 – C 60-69 – D <60 – F

Course Outline – ASTR 620 – 2019 Spring Semester

Class Date	Week #	Lecture Topics	Notes
1/22	1	Course Overview Exoplanet History	
1/24	1	--	
1/29	2	Solar System Formation & Review	Train each other on telescope & CCD!
1/31	2		
2/5	3	Keplerian Orbits Pt 1	
2/7	3		
2/12	4	Keplerian Orbits Pt 2	Project Formulation
2/14	4		
2/19	5	Detection Techniques: Transits Pt 1	
2/21	5		
2/26	6	Detection Techniques: Transits Pt 2	Project Observations
2/28	6		
3/5	7	Detection Techniques: Radial Velocities	
3/7	7		
3/12	8	No Class	Spring Break
3/14	8		Spring Break
3/19	9	Detection Techniques: Direct Imaging & Future Space Missions	
3/21	9		
3/26	10	Detection Techniques: Microlensing	
3/28	10		
4/2	11	Exoplanet Demographics	
4/4	11		
4/9	12	Planet Formation	
4/11	12		
4/16	13	Planetary Atmospheres	
4/18	13		
4/23	14	Planetary Habitability	
4/25	14		
4/30	15	Project Presentations	
5/2	15	Project Presentations	Last Class

Course Description:

Are there other Earth-like planets out there? Humanity has pondered this question for millenia. Over the past 25 years, over 3500 exoplanets have been confirmed and/or validated to orbit other stars. These discoveries accelerated with the launch of the NASA Kepler mission in 2009, and will continue to accelerate with the launch of future NASA and European missions such as TESS, the James Webb Space and WFIRST, and with new ground-based observatories and instrumentation. We now know exoplanets outnumber stars in our Galaxy, and that Earth-mass exoplanets with the potential for liquid surface water exist by the billions in our Galaxy alone. Science fiction is now science fact.

This course will cover the modern knowledge of exoplanets, including the recent history of the field, the different discovery methods, important benchmark exoplanets and exoplanetary systems, and the characterization of exoplanet demographics, composition and atmospheres. We will explore the different tools and techniques employed, making use of theory, simulation, archival research and observations. The field of exoplanet science is fundamentally driven by a revolution in the obtainable precision of traditional astronomical measurements, which have in turn been enabled by new technology, the exploitation of the time domain, and new advanced algorithms that take advantage of increasing computational resources and improved statistical methods. In this course, we will make use of the technology, algorithms, and statistical methods that underlie these advances in precision and look towards the future unexplored vistas of the exoplanet field.

Overall goal:

The goal of this course is to establish proficiency in the theoretical, observational, statistical, computational techniques used by exoplanet astronomers at the graduate student level.

The skills you will develop in this class are extremely useful for a wide variety of careers including, but not limited to, professional astronomy. We are committed to making this course useful for your future career goals, whatever they may be.

Specific Graduate level goals:

- You will be able to **independently** operate the campus telescope such that you can select a source, take a sequence of images of your source and the necessary calibration images, and use AstroImageJ to generate a light curve of a transiting exoplanet.
- You will show that you can extract information from light curves of transiting exoplanets to draw scientific conclusions about the exoplanet that you have observed.

You will show that you can describe scientific work to professional astronomers by giving a presentation of your final project to the class and preparing a paper of the work for the community of professional astronomers.

Unique to graduate level course:

- You will show that you can evaluate the statistical significance of the conclusions you draw from your observational data, specifically application of frequentist and Bayesian statistical analyses.
- You will demonstrate expert execution of custom computational programs and tools for data analysis and model generation. You will be able to run custom programs independently and create your own computational tools.
- Homeworks and readings will be assigned from the course textbooks, appropriate for graduate level mastery of exoplanet detection, characterization and demographics.
- Assigned homeworks will be graduate level, and will include more difficult and additional questions with respect to the undergraduate course. Graduate level coursework will involve developing custom data analysis tools (see below).
- Exams will test your knowledge of the material at a level suitable to continue to pursue research for a PhD thesis in exoplanets.

Computers:

The use of computers is fundamental to astronomical work so they are going to play a very important role in this class. For data reduction, we will use astroImageJ. We will also use other professional software for detailed plotting and analysis of the reduced data (such as TOPCAT, ExoFAST, the NASA Exoplanet Archive tools and others).

Specific to graduate level course:

Working with computer programs takes time and effort, but these are important and very marketable skills for future jobs. Take the time to work on your computer skills and particularly your programming skills and you will reap the benefits in this class and in looking for jobs in the future.

Telescopes:

Using telescopes is always a bit tricky and never works as you plan it. There will undoubtedly be obstacles to deal with including instrumentation that does not always work as planned and weather that can sometimes be uncooperative. You will spend some of our unscheduled class time learning to use this facility if you have not already done so.

Useful Campus Resources:

Writing Center: A114 Robinson Hall; (703) 993-1200; http://writingcenter.gmu.edu

Counseling and Psychological Services (CAPS): (703) 993-2380 http://caps.gmu.edu

Policies:

Withdrawal: If you need to withdraw from this course you must do it within the University established time frame. See the GMU academic calendar http://registrar.gmu.edu/calendars/fall-2017/ for important dates.

Students with Disabilities: Please contact Disability Services (SUB I, Room 4205, Phone 703-993-2474, http://ods.gmu.edu if you have a learning or physical disability that will require accommodation in the astronomy laboratory. You must obtain the proper paperwork and notify your instructor in advance to be accommodated.

Academic Integrity:

GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. Collaborative group work is encouraged in the lab, but it will be considered academic dishonesty to attach your name to work when you did not actively participate and contribute.

Sexual Harassment, Sexual Misconduct, and Interpersonal Violence

As a faculty member and designated "Responsible Employee," I am required to report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's *Title IX Coordinator* per *university policy 1412*. If you wish to speak with someone confidentially, please contact the *Student Support and Advocacy Center* (703-380-1434), *Counseling and Psychological Services* (703-993-2380), *Student Health Services*, or *Mason's Title IX Coordinator* (703-993-8730; cde@gmu.edu).

Project Paper – Graduate Course

The goal of the project paper is to describe the observations, data reduction, and results of your research project suitable for publication in the professional astronomical literature. The format for this paper will follow the format of the peer-reviewed **Astrophysical Journal Letters of the American Astronomical Society**. The audience for the paper will be a professional scientific audience – it should be written at the level appropriate for an ApJL article. The primary components of your paper will be:

1) <u>Abstract</u>: an overview of what has been done and the results of your project.
2) <u>Introduction</u>: explains the motivation for this project, why it is of interest and what the goals of the project are.
3) <u>Observations:</u> Discuss all of the observations you have and details including but not limited to: telescope used, types of observations take, duration of observations,
4) <u>Analysis</u>: describes the details of the data reduction procedure you have done, including all calibration, photometry, etc.
5) <u>Results</u>: describes the results of your project. This section should be about the science that was done with the data.
6) <u>Discussion</u>: this section describes how your results fit within the context of the existing literature on your observational topic. You must review the existing literature to interpret the uniqueness of the results that you have contributed, and compare and contrast your results with similar publications.
7) <u>Conclusions:</u> this section describes how your results fit with the hypothesis that you made in your Introduction.
8) <u>References</u>: bibliography in the style of the ApJ Letters.

These projects will be done ***individually,*** and so will the write-ups. Also make sure that anyone else that contributed is an author, or is cited in the acknowledgements if they were part of a useful discussion of the work or contributed a useful idea (but not a significant part of the results).

30 minute Project Presentation - Graduate Course

Presenting your research is an important skill as a professional astronomer. It is also a skill that crosses many disciplines and professions. At the end of the semester we will have a presentation session (or two depending on the number of students) in which each graduate student will present the research they have done over the course of the semester. The talk should be directed at professional astronomers (i.e., faculty, research scientists and postdoctoral scholars)– we may have additional people viewing the talks, but this is still your target audience). Important things to include in the talk:

- Background material explaining what has been done before in this field. This is where you set the stage for the project you have just executed.
- An explanation of why you pursued this particular project, why it is interesting, and what questions you hoped to answer. This is where you lay out the hypothesis that you made.
- A thorough discussion of your observational method, data reduction, and analysis.
- Summary of your results, discussion of whether your results support or negate your hypothesis, discussion of where these results fit within the larger context of the field and the literature. This section could also include a revision of the hypothesis and discussion of possible future work.