Astronomy 250 (Special Interest Seminar): Adaptive Optics

Syllabus – Fall 2013, UC Berkeley

Instructor	Dr. Gaspard Duchêne
Office	Hearst Field Annex C-203 (badge needed to enter – contact instructor)
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Class Time	Wed. 1-3pm, with a short break halfway
Clas location	Hearst Field Annex B-40 (badge needed to enter – contact instructor)
Office Hours	By appointment

COURSE SUMMARY

This course will provide an overview of adaptive optics (AO), whose use has become increasingly mainstream over the last two decades in astronomy as well as in a variety of other fields. The course will discuss the motivation for, basic principles, and key elements of AO systems. Historical breakthroughs and achievements over the last 40 years will be analyzed and used to introduce future developments. While the primary emphasis for the course will be on night-time astronomical systems, AO systems in other contexts will be also considered during the class (solar observations, retinal imaging, imaging microscopy, ...). Current limitations of AO observations in terms of resolution, image quality and contrast will be described and quantified. Besides the traditional "single natural guide star" flavor of AO, the course will also cover the principles and specificities of more advanced types of AO systems, such as laser guide star AO, multi-conjugate AO, ground layer AO and "extreme" AO. The course will also cover a broad range of observing and post-processing techniques aimed at improving the scientific return of AO-aided observations (and related high spatial resolution observing techniques), with particular emphasis on techniques aimed at improving their resolution and/or contrast. The course is primarily intended for students who will either use AO systems for their science projects and/or who will develop new systems in astronomy or other fields.

TOPICS COVERED IN CLASS (not necessarily in order of lectures)

– Image formation, resolution and other image quality metrics, effect of optical aberrations
– Atmospheric turbulence: properties and consequences for astronomical imaging
– Basic concepts of AO and historical developments
– Wavefront sensing techniques, characterization of distorted wavefronts
– Deformable mirrors and other phase modulation devices
– Principles of (real-time) control methods
– Adaptive optics in other contexts: solar observations, retinal imaging, biological microscopy, ...
– Advanced astronomical adaptive optics system (laser guide star, ...)
– Doing science with adaptive optics data: instrumentation, post-processing
– Techniques for high-contrast imaging with adaptive optics
– Design plan for an adaptive optics system
– Long-baseline interferometry

READINGS

R. Tyson, *Principles of adaptive optics* (CRC Press) covers most the theory of adaptive optics (available at UCB's Engineering Library). Other readings (book chapters and journal articles) will be used as complement on a weekly basis. They will be assigned gradually.

CLASS ORGANIZATION

The class will feature a weekly lecture summarizing the key concepts, as well as extensive discussions of the week's readings. A final class project will consist in developing either a new research project using adaptive optics, or the a particular system's concept designed to achieve a particular scientific goal.