SYLLABUS for Spring 2022 CORE-UA 209 Physical Science: Quarks to Cosmos

Class meeting time: T,Th 8:00 AM – 9:15 AM Room 914 Kimmel Center

Prof. Allen Mincer (he/him) 726 Broadway Room 850 allen.mincer@nyu.edu

Student hours - in person or via Zoom - are by appointment. Just send me an email listing some
days and blocks of time during which you can meet and we will find a time that works.

Course assistants: Lauren Jones, Ben Mor

Laboratory: Room 161 Meyer Hall (4 Washington Place)

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<th>Section</th>
<th>Instructor</th>
<th>Email</th>
<th>Student Hours</th>
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<td>2</td>
<td>Xuyao Hu</td>
<td><a href="mailto:xh837@nyu.edu">xh837@nyu.edu</a></td>
<td>TBA</td>
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<td>3</td>
<td>Chandrika Manohara</td>
<td><a href="mailto:cm5877@nyu.edu">cm5877@nyu.edu</a></td>
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<td>Xuyao Hu</td>
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<td>Chandrika Manohara</td>
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COURSE DESCRIPTION:

Modern science has provided us with some understanding of age-old fundamental questions,
while at the same time opening up many new areas of investigation. How old is the Universe?
How did galaxies form? What are the fundamental constituents of matter and how do they
combine to form the contents of the Universe? The course will cover measurements and chains of
scientific reasoning that have allowed us to reconstruct the Big Bang by measuring little wisps of
light reaching the Earth, to learn about sub-atomic particles by use of many-mile long machines,
and to combine the two to understand the Universe as a whole from the sub-atomic particles of
which it is composed.

COURSE COMPONENTS:

As explained in the following, this is a “flipped” course. It includes pre-recorded lessons, in-class
activities, homework, and laboratory. The lessons and homework can both be accessed via the
Brightspace site for this course, which can itself be accessed in NYU Home by searching for
Brightspace in the “Search NYU Services” area. The “About This Course” and “Getting Started”
sections there explain a bit about the course. To access these, navigate to the course, click on
Content in the top menu and then on Course Overview on the left side.

The full set of lectures for the course have been pre-recorded by the professor and are available on
the class Brightspace site. Just navigate to the course contents as described above and then click on
the appropriate week. The lectures are linked in the “Before Class” section. You are required to
view the lectures for each class before coming to that class. Note that by clicking on the icon in the
upper left of the video you can leave questions (automatically linked to the video time) which will
periodically be answered. There are several lectures per class session, and, except for the first class,
each lecture is followed by one or more graded Learning Checks. You may watch any segment as
many times as you wish before attempting the required Learning Checks. If you get a Learning
Check wrong, review the material and try again. The point of the Learning Checks is for you to
gauge whether you have understood the material well enough to go on on to the next lecture, so
don’t just guess until you get the correct answer! Only your last response will be graded. The
The deadline for completing each set of lectures and Learning Checks is 11:55pm on the evening before the class covering that material. The specific due dates are posted on the site.

Class meetings will consist of working on collaborative small-group problems and activities. These activities are designed to review and complement the lessons by exploring the implications of the subjects discussed. Class attendance is required; responses to activities are to be submitted during class and will be graded. The course professor and assistants oversee the in-class activities and answer questions, but the goal of the activities is for classmates to help each other think through the ideas that are being studied. In-Class activity responses will use Google Doc documents that are downloaded via Brightspace by one of the group members, shared with and filled in by the entire group, and then uploaded to Brightspace for grading of the group. More detailed instructions will be provided in the Brightspace “During Class” section.

Homework assignments are accessible on the class Brightspace website in the “After Class” section. These are designed to reinforce the lessons and to provide practice in applying the ideas to problems. HW due dates are displayed on the site. HW assignments are normally due 7:55am on the Monday morning following the week in which the material is covered. The exceptions are the two weeks in which there are exams on Tuesday, for which the HW is due on the following Monday instead of the day before the exam. The specific due dates are posted on the site.

You must be registered for a laboratory section as well as lecture. The labs are designed to provide some feel for and appreciation of how one actually performs the sorts of measurements described in the lessons, and how one arrives at conclusions based on measurements. At the beginning of each lab there will be a short quiz to determine whether you have read the laboratory manual section for the experiment before coming to class. Reports for each lab are to be submitted in a manner and according to a schedule that will be described by your laboratory instructor. Unexcused absence from 3 or more labs will result in a zero for the lab component of the grade.

If you know ahead of time that you must miss a class or lab for a valid reason (eg., religious observance) please inform your instructor ahead of time.

There will be two exams during the semester and a final exam. Much of the material in the course cannot just be memorized but requires pondering; learning checks, in-class activities, homework and laboratory provide good preparation in this regard.

TEXTBOOKS:

- There is no required textbook for the lecture part of this course.
- There is a required Laboratory Manual which can be purchased at the NYU book store.

COURSE GRADING:

- Learning Checks 10%
- 2 Midterms 15% each
- Final 15%
- HW 15%
- Laboratory 20%
- In-class activities 10%
DISABILITY ACCOMMODATIONS:

I am committed to creating an inclusive and accessible classroom environment for students of all abilities. Students who may need academic accommodations are advised to reach out to the Moses Center for Student Accessibility as early as possible in the semester for assistance (212-998-4980 or mosescsd@nyu.edu). Information about the Moses Center can be found at http://www.nyu.edu/csd. Knowing that ability status may shift during our time together, please let me know how I can best support your learning needs. If you need any support in connecting with the Moses Center or other resources, please also let me know.

HEALTH AND WELLNESS:

To access the University's extensive health and mental health resources, contact the NYU Wellness Exchange. You can call its private hotline (212-443-9999) or chat (in six different languages) via the Wellness Exchange app available 24 hours a day, seven days a week, to reach out to a professional who can help to address day-to-day challenges as well as other health-related concerns. Email wellness.exchange@nyu.edu.

COURSE SCHEDULE:

Please see the following two pages.
SCHEDULE

**************************************** WEEK 1 ****************************************
Jan. 25: Class 1 – Introduction, Physical laws and theories, distance scales, unit conversions

Jan. 27: Class 2 – Experimental error and uncertainty, hypothesis testing

Jan 27: No lab this week

**************************************** WEEK 2 ****************************************
Feb. 1: Class 3 – Geometrical methods, parallax

Feb. 3: Class 4 – Orbital motion, Kepler’s laws, size of the solar system

Feb. 3: Lab – Measurement and Uncertainty

**************************************** WEEK 3 ****************************************
Feb. 8: Class 5 – Properties of motion, causes of motion, position, displacement, velocity, and acceleration.

Feb. 10: Class 6 – Forces, Newton’s Laws

Feb. 10: Lab – Parallax

**************************************** WEEK 4 ****************************************
Feb. 15: Class 7 – Gravitation

Feb. 17: Class 8 – Energy

Feb. 17: Lab – Kinematics

**************************************** WEEK 5 ****************************************
Feb. 22: Class 9 – Electric forces

Feb. 24: Class 10 – Magnetic Forces, Thomson experiment, electrons

Feb. 24: Lab – Review for Exam 1

**************************************** WEEK 6 ****************************************
Mar. 1: Class E1 – Exam 1 on material of Weeks 1 through 4.

Mar. 3: Class 11 – Atoms, electrolysis, Millikan experiment, mass and charge of electrons and atoms

Mar. 3: Lab – Newton’s 2nd Law of Motion

**************************************** WEEK 7 ****************************************
Mar. 8: Class 12 – Waves

Mar. 10: Class 13 – Radioactivity, nature of the atom, Rutherford experiment

Mar. 10: Lab – Measuring the Size of a Molecule

Spring Break: No classes or laboratory

**************************************** WEEK 8 ****************************************
Mar. 22: Class 14 – Photoelectric Effect, wave/particle properties of light, quantum physics
Mar. 24: Class 15 – Light emission and absorption, atomic energy levels, blackbody radiation

Mar. 24: Lab – Measuring Avogadro’s Number

Mar. 29: Class 16 – Doppler Effect

Mar. 31: Class 17 – Distances to stars and galaxies, inverse square, standard candles

Mar. 31: Lab – Review for Exam 2

Apr. 5: Class E2 – Exam 2 on material of Weeks 5 through 9

Apr. 7: Class 18 – Olbers’ paradox, Hubble’s law, Big Bang

Apr. 7: Lab – Interference and Diffraction of Light

Apr. 12: Class 19 – Special relativity 1

Apr. 14: Class 20 – Special relativity 2

Apr. 14: Lab – Photoelectric Effect

Apr. 19: Class 21 – General relativity

Apr. 21: Class 22 – Isotopes, nuclear stability, neutron, anti-particles, conservation laws

Apr. 21: Lab – Measuring Doppler Effect

Apr. 26: Class 23 – Spin and parity, strong and weak nuclear forces, muons, pions, neutrinos, baryons, leptons, and exchange particles

Apr. 28: Class 24 – Strange particles and more particles and properties, quarks, the Standard Model, experimental particle physics, discovery of the Higgs.

Apr. 28: Lab – Inverse Square Law: Measuring Light Intensity

May 3: Class 25 – Dark Matter, Cosmology 1

May 5: Class 26 - Last class meeting, Cosmology 2

May 5: Lab – Review for final

TBA: The final exam data, time, and location.