**AST 390: Special Topics: Black Holes, Neutron Stars and Gravitational Waves**

**Spring 2024**

**TuTh 10:00 -- 11:20, Hum 3018**

**Instructor:**[**James Lattimer**](https://www.google.com/url?q=http://www.astro.sunysb.edu/lattimer/index.html&source=gmail-html&ust=1706015879820000&usg=AOvVaw0GGh3Dbmsre8TkmRZlcoa0)**James.Lattimer@Stonybrook.edu**

**Office Hours: MTh 2:00 -- 3:30; or as requested**

* + - **Course URL is**[**http://www.astro.sunysb.edu/lattimer/AST390/**](https://www.google.com/url?q=http://www.astro.sunysb.edu/lattimer/AST390/&source=gmail-html&ust=1706015879820000&usg=AOvVaw2nAIGFs7zvM_pbKKbXGGLY)

**This is a special topics course covering many aspects of relativistic astrophysics, but will focus on black holes, neutron stars and gravitational radiation. In addition, nucleosynthesis, gamma-ray bursts, supernovae and relativistic cosmology will be studies.**

**The first class meeting, on January 23, will be informational only and the lecture will be deferred to a later date. The second class meeting, on January 25, will also be deferred to a later date. I will arrange the make-up classes for dates and times that are suitable and agreeable for everyone. If necessary, I will repeat those lectures either in person or by Zoom to accomodate everyone.**

* + - **Required texts: Shutz: A First Course in General Relativity, Second Edition**
		- **General References: "Compact Star Physics" by Schaffner-Bielich (enter code CSP2020 to get 20% discount; highly recommended)**

**"Black Holes, White Dwarfs and Neutron Stars" by Shapiro & Teukolsky**

**"Neutron Stars 1: Equation of State and Structure" by Haensel, Potekhin & Yakovlev**

**"Compact Objects in Astrophysics: White Dwarfs, Neutron Stars and Black Holes" by Camenzind (heavily mathematical and GR)**

**"Introduction to Black Hole Physics" by Frolov & Zelnikov**

**"Principles of Stellar Evolution and Nucleosynthesis" by Clayton**

**Homeworks: Homeworks are posted on Blackboard at least one week before they are due. Completed homeworks must be submitted by the due date or they will be downgraded. There will be about 10 homework assignments that will count for 40% of your final grade. Generally, these will consist of short computer or analytical exercises. You may use whatever computing languages you wish, and I ask that you submit your code and present your results as tables and/or figures. I am not opposed to groups working on homeworks together, especially for researching, but this must be limited to discussions among yourselves. The submitted homeworks and any computer codes are to be your own creation and you must not plagiarize from one another.**

**Reports: Two reports will each count 30% of the total grade. The due dates for the reports are March 8 and April 19, and they are to be submitted to Brightspace. Late papers will be downgraded 1 letter grade for each week they are overdue. We may want to discuss some of these reports in class. Suggested topics for the first term paper will be discuseed for the first few weeks of classes, or you can propose alternant topics if you wish. Topics should refate to course material and themes from the syllabus up to due due date for the first paper. Suggested topics for the second topic will be discussed during week 5, and should relate to topics discussed during the second half of the course. A paper's length should be about 12 double-spaced typed pages, not counting figures and tables, but this is not a hard and fast rule. I am happy to discuss your paper or look at an outline during office hours or other arranged times at your convenience. For each paper, it is expected that you should find appropriate sources and use an Astrophysical Journal or Physical Review citation style. You might find using latex is the easiest way to proceed. If prepared this way, the papers will be suitable to satisfy the AST writing requirement for AST 459.**

**Grades will be posted on Brightspace.**

* + - [**Lecture notes are posted here**](https://mail-attachment.googleusercontent.com/attachment/u/0/?ui=2&ik=bebbbcdb43&attid=0.1&permmsgid=msg-f:1788791063211160766&th=18d30ffe9c1834be&view=att&disp=inline&realattid=f_lrov4v080&ser=1&saddbat=ANGjdJ9nOK6qtjxCHhgh1adJ_f4PI90EjCUJ2cgmjYrUeiWk1bnOWdDtMrxZpaM4uCHnKP9J9FZUObuDbwObOmTY794e_FZbXFoM44UTeZsXCZ-yiSrgSxiBR-KKix2eN4EirmMblfDchLRuH-E5Ru9Q1w5Y_kwwjLrJBbwBCFNGqlK7b76YlJouU8nXqLE7138xAOcaxzAN5EHUb2UA1o_xFFmhe0VYqT4P6YFaNEvjzjUQlToZx2Tfa2-PKC0iOejgoJ3qX8OP9ux19xmDShlTJ83_lsp28uBzk84qiThH7mHMGwcHQ3fSugVBNX3_sGZZf0FTZbsnLoq9m7Oyr50ESazTT0Y7E7EE-2khhu-uEBJEHo8irLabJR5Escqi2LHb_gEjcap_IjKes2ajIbKWln3lj1Q7AEUJ5_zXOsdvf6KOQ6GIFnTlUenu8yYPagtMkR_kgJHEdo-nH-6dqFmD682Evf6en3t1xlaQqfGjGbiNtiz0XAFW71WZBfdCTGqo-x8HyBNGa56PnDhef3UuaEAs9900zFTl4URUzGhPmgI309_cwbXDDOMcwcQPErNwjA-YzV1KsdaOEy-ioRc-tGedXdOnyfSVRYBZjcOeIViTKh73EUvqSSwiSs6xFJCoscb6pghZCQO7pT49fG6vOqSIfTyZ2RZvksMbivL-JLovRWRN1c_JtQA0P6wNCDx-TbirZWhHUXoBsKJHYa6DsyPehEbBe0w2WRo93hqdhCkZDdhNX3WkBcSiclyCa-4Ye_jo-uT6QO_4DzzKpCm07E3P6NTHrw7pMNVFUcUFLek36p_mtYhFjFrh6N436VWC7IqlICPItnJPo-agUZm04ugvqQtX7A26kzKagstzBIZ7bS1qLHwdFza6q0npf9CS9vOgnlJyBP8IFd6tBPa5FV7ZNsEY2uajaPAgxexQcNoWzgeB8JGNxKqRytiIJjwAqFipey-TV3uxGBNhcGaGfsMMrOVLB8eY3lcEDXKSFf0_-KH_YFzEqnhVo3Qejp64PNdqlSluT_t0IN6r#m__lecnotes)**. They are continuously being updated, even past the posted dates. Please send errors and corrections to me if you note any.**

**LECTURE NOTES**

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| --- |
| January 2024 |
| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
| 21 | 22 | [23](https://www.google.com/url?q=http://intro.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw2BV_RtQEqRO6A2fqB-4g7e) | 24 | 25 | 26 | 27 |
| 28 | 29 | [30](https://www.google.com/url?q=http://intro.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw2BV_RtQEqRO6A2fqB-4g7e) | 31 | [1](https://www.google.com/url?q=http://gr390.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw3z7BkAmcA9VtS-9lzztj03) | 2 | 3 |
| **February 2024** |
| 4 | [5](https://www.google.com/url?q=http://gr390.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw3z7BkAmcA9VtS-9lzztj03) | 6 | [7](https://www.google.com/url?q=http://gr390.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw3z7BkAmcA9VtS-9lzztj03) | 8 | 9 | 10 |
| 11 | [12](https://www.google.com/url?q=http://gr390.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw3z7BkAmcA9VtS-9lzztj03) | 13 | [14](https://www.google.com/url?q=http://gr_orbit.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw0WUdlZsYZn-yLredasjoMx) | 15 | 16 | 17 |
| 18 | [19](https://www.google.com/url?q=http://gr_orbit.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw0WUdlZsYZn-yLredasjoMx) | 20 | [21](https://www.google.com/url?q=http://gr_kerr.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw3_jloG6lmdEQfBV_w3bWte) | 22 | 23 | 24 |
| 25 | [26](https://www.google.com/url?q=http://gr_lens.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw1LCBS-Oa188JqW0jDAlcvJ) | 27 | [28](https://www.google.com/url?q=http://gr_lens.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw1LCBS-Oa188JqW0jDAlcvJ) | 29 | 1 | 2 |
| **March 2024** |
| 3 | [4](https://www.google.com/url?q=http://gr390_ns.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw1ABftIm1eFPtnBuXf4nd2B) | 5 | [6](https://www.google.com/url?q=http://gr390_ns.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw1ABftIm1eFPtnBuXf4nd2B) | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | [18](https://www.google.com/url?q=http://eosdm.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw2gf4kcx2j22LUA-y_6bJ-M) | 19 | [20](https://www.google.com/url?q=http://eosdm.pdf&source=gmail-html&ust=1706015879820000&usg=AOvVaw2gf4kcx2j22LUA-y_6bJ-M) | 21 | 22 | 23 |
| 24 | [25](https://www.google.com/url?q=http://eosdm.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw0hhx77HUIlmTs3uH1Wp5Hx) | 26 | [27](https://www.google.com/url?q=http://eosdm.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw0hhx77HUIlmTs3uH1Wp5Hx) | 28 | 29 | 30 |
| **April 2024** |
| 31 | [1](https://www.google.com/url?q=http://gwns.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw1NSjYnBR23eisnyYkGqGBa) | 2 | [3](https://www.google.com/url?q=http://gwns.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw1NSjYnBR23eisnyYkGqGBa) | 4 | 5 | 6 |
| 7 | [8](https://www.google.com/url?q=http://gwns.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw1NSjYnBR23eisnyYkGqGBa) | 9 | [10](https://www.google.com/url?q=http://gwns.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw1NSjYnBR23eisnyYkGqGBa) | 11 | 12 | 13 |
| 14 | [15](https://www.google.com/url?q=http://gwaves.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw2764jXB2nn35cduKS-IaC_) | 16 | [17](https://www.google.com/url?q=http://gwaves.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw2764jXB2nn35cduKS-IaC_) | 18 | 19 | 20 |
| 21 | [22](https://www.google.com/url?q=http://gwaves.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw2764jXB2nn35cduKS-IaC_) | 23 | [24](https://www.google.com/url?q=http://gwaves.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw2764jXB2nn35cduKS-IaC_) | 25 | 26 | 27 |
| **May 2024** |
| 28 | [29](https://www.google.com/url?q=http://gwaves.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw2764jXB2nn35cduKS-IaC_) | 30 | [1](https://www.google.com/url?q=http://explosions.pdf&source=gmail-html&ust=1706015879821000&usg=AOvVaw0fK0gvfDu2aTqMsVZaiE-w) | 2 | 3 | 4 |