Term Project: Final Paper – PHYS 6260
Prof. John Wise
Due Monday May 1, 11:59pm (Uploaded to Canvas; One per group)

- 50% of the total project grade. Will be graded for completeness and presentation of the following material.

Write a report with the following items and length. Upload a PDF of this report that contains a link to your Github repository. Please list all group members in your proposal.

Report length The following page counts (excluding figures, tables, references) are guidelines. The word count is the more relevant length metric. Aim for that figure ±10%.

- Individual projects: 8–10 pages but no more than 12 pages, roughly 4,000 words
- Group projects: 12–15 pages but no more than 18 pages, roughly 6,000 words
- Single spaced, 12 point font, 1-inch margins

Write your final report with the structure of a journal article containing the following components. One can look at papers on arXiv for examples of papers.

Title, author information and abstract (5 points). See the next page for guidelines on how to write an abstract (from Nature).

Introduction (15 points) including theoretical background material on the physics being simulated, literature review, statement of the problem, and the motivation behind using a numerical (rather than experiment or analytic) approach solution. Include references throughout the introduction.

Methods (30 points) describing the formulation of an algorithm and development of your program to solve the project. You can create figures and diagrams to illustrate the procedures used in the program. Be sure to include any limitations of the numerical methods.

Results (30 points) describing and discussing data and analysis of running your simulation code for physical interesting domains of variables and parameters. Captions are required for figures and plots shown in the paper. The figures should have axes labels and legends (if necessary) for different curves. When appropriate, compare the solution of the problem to analytical results or other known results with appropriate references being given.

Summary and conclusions (20 points) including the outcomes of the solution and effectiveness of the algorithm and program to solve the problem.

nature

How to construct a *Nature* summary paragraph

Annotated example taken from *Nature* **435**, 114-118 (5 May 2005).

*One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.*

*Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.*

*One sentence clearly stating the **general problem** being addressed by this particular study.*

*One sentence summarising the main result (with the words "**here we show**" or their equivalent).*

*Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.*

*One or two sentences to put the results into a more **general context**.*

*Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline, may be included in the first paragraph if the editor considers that the accessibility of the paper is significantly enhanced by their inclusion. Under these circumstances, the length of the paragraph can be up to 300 words. (The above example is 190 words without the final section, and 250 words with it).*

During cell division, mitotic spindles are assembled by microtubule-based motor proteins[1,2]. The bipolar organization of spindles is essential for proper segregation of chromosomes, and requires plus-end-directed homotetrameric motor proteins of the widely conserved kinesin-5 (BimC) family[3]. Hypotheses for bipolar spindle formation include the 'push–pull mitotic muscle' model, in which kinesin-5 and opposing motor proteins act between overlapping microtubules[2,4,5]. However, the precise roles of kinesin-5 during this process are unknown. Here we show that the vertebrate kinesin-5 Eg5 drives the sliding of microtubules depending on their relative orientation. We found in controlled *in vitro* assays that Eg5 has the remarkable capability of simultaneously moving at ~20 nm s^{-1} towards the plus-ends of each of the two microtubules it crosslinks. For anti-parallel microtubules, this results in relative sliding at ~40 nm s^{-1}, comparable to spindle pole separation rates *in vivo*[6]. Furthermore, we found that Eg5 can tether microtubule plus-ends, suggesting an additional microtubule-binding mode for Eg5. Our results demonstrate how members of the kinesin-5 family are likely to function in mitosis, pushing apart interpolar microtubules as well as recruiting microtubules into bundles that are subsequently polarized by relative sliding. We anticipate our assay to be a starting point for more sophisticated *in vitro* models of mitotic spindles. For example, the individual and combined action of multiple mitotic motors could be tested, including minus-end-directed motors opposing Eg5 motility. Furthermore, Eg5 inhibition is a major target of anti-cancer drug development, and a well-defined and quantitative assay for motor function will be relevant for such developments.