**Topics**: Star formation, including HSEQ, the Virial Theorem, cloud collapse, and pre-main-sequence evolution

**Reading**:

- Read all of LeBlanc, Ch. 2.
- Using *Astronomy Picture of the Day* or some other resource, find images of the Eagle Nebula pillars taken by the Hubble Space Telescope, including one showing the so-called EGGs. And including one in the infrared. Find optical, infrared, and X-ray images of the Orion Nebula Cluster, too. And find some ALMA images of forming stars with accretion disks around them.

**Summary of work to be produced**:

- Hand in your solutions to the warm-up questions (QW2 and QW5) by Thursday at 12:30 pm in the box on the wall outside my office.
- Bring solutions to seminar on Friday for all the (non-warm-up) numbered problems. Bring a xeroxed copy to give to me at the beginning of class, and expect to take notes on your original solutions.

**Scope**: We'll go over the problems and your solutions in seminar, but I also anticipate we'll go over: the derivation of hydrostatic equilibrium, the solution of HSEQ for constant gravity and temperature, the derivation of the virial theorem – and its interpretation – and the Jeans mass criterion and its derivation. We'll also discuss the physics and phenomenology of pre-main-sequence stars and their accretion disks (pay attention to Figs. 2.6 and 2.7 and the descriptions of the physics in sec. 2.6 even though there are no worked problems directly relevant to much of that material – be ready to discuss it and ask questions).

And of course, be ready to discuss the implications, meaning, relevance of any problem you present (or a classmate presents).


This is the Herbig-Haro Object HH24 – a pre-main-sequence star with polar jets that are associated (sometimes) with an accretion disk. Read more about it on APOD: https://apod.nasa.gov/apod/ap180311.html.

**Questions etc.**:

**Q1a** Do problem 2.1 at the end of the chapter. Do the integral **by hand**. You can check it with Wolfram alpha or Mathematica – if you do, take a screen shot and hand it in with your solution.

**Q1b** For the previous problem (2.1), plot the density, pressure, and temperature (assuming a perfect gas) as a function of the height above the surface, $r$, and all on the same graph. Scale the variables to their values at the surface. (Incidentally, it's not standard to use $r$ to be the height; we'll generally assume the variable $r$ is measured from the center of the object, but not in this problem.)

**QW2a** Problem 2.2. Do the integral here by hand, too. For a boundary condition, assume that the pressure is zero at the surface.

**QW2b** For the previous problem, compute the central temperature (again assuming a perfect gas) for the Sun – use the properties of the actual Sun, but because of the assumptions of this problem, use the Sun's *average* mass density, $\rho$.

**Q3** Problem 2.3. Here you can solve the integral using a computer (e.g. Wolfram alpha). But set it up clearly and completely by hand before solving it. Include a hardcopy of your computer solution. You may do it by hand if you prefer.

**Q4** Problem 2.4.

**QW5** Problem 2.5.

**Q6** Problem 2.6.

**Q7** Problem 2.7.

**Q8** Problem 2.8.

**Q9** Problem 2.9.