ASTR 4008/8008: Star Formation

Semester 2, 2020
Lecturer / convenor: Mark Krumholz
Class meeting times: Tuesdays and Thursdays, 1 - 3 pm
Class location: Duffield Lecture Theatre
Course web page: http://www.mso.anu.edu.au/~krumholz/teaching/astr8008_s2_2020/

Topics

This course covers the basics of star formation and the transition to planet formation. We begin with a survey of the physical processes that govern star-forming clouds, including magnetohydrodyanmic turbulence, gravitational instability, non-ideal MHD effects, and radiative transfer by molecules and dust grains. We then study the star formation process starting at galactic scales and working our way down, touching on topics including: star formation laws; molecular cloud formation, evolution, and disruption; collapse, fragmentation, and the origin of the initial mass function; protostellar disks and outflows; pre-main sequence stellar evolution; massive stars and feedback; and the dispersal of disks and the onset of planet formation.

Texts

The main text for this class my book *Star Formation*. Paper copies can be purchased from amazon and many other online book sellers. A free PDF copy is available as part of the Open Astrophysics Bookshelf, and can be found at http://bender.astro.sunysb.edu/oab/star_formation_notes/sfnotes.pdf.

Assessments

This course has three forms of assessment:

- There will be 5 problem sets, due on the dates indicated in the schedule below. These can be submitted via the course wattle page, or on paper. The problem sets together form 40% of the total assessment, and are all weighted equally. Late submissions will be accepted, at a penalty of 5% of the credit per working day, up to one week past the original due date, at which time I will distribute solution sets.

- Each student will give one in-class presentation summarising a paper from the recent research literature, and lead a discussion of that paper. Presentations and discussions should be approximately 30 minutes each. Every student is expected to read the paper and to submit questions/comments for discussion to the student who is leading the discussion in advance. This item is 30% of the total course grade. Assessment will be based mainly on the presentation/discussion that each student leads, but the quality of participation in discussions led by other students will be considered as well.

- There will be an oral final exam during the exam period, which will be scheduled individually. This exam will last approximately 45 minutes, and will consist of making rough estimates, order of magnitude calculations, scaling arguments, and similar quick calculations of the type that one is likely to encounter during a discussion at a scientific conference or similar venue. The exam is worth 30% of the total course grade.

Policy on collaboration

Group work is encouraged in this course. In particular, if your understanding is lacking in places, I strongly encourage you to discuss and debate with other students to reach a better understanding. However, this should not lead to a number of students producing identical assignments. In the end, you must work through, understand, and answer the assignment

questions yourself, not simply reproduce verbatim other students' work. See links for further information on ANU policies on plagiarism and collusion.

Schedule

Date	Topic	Chapter	Paper	Work due
28 Jul	Observing the cold ISM	1		
30 Jul	Molecular line emission	App. A		
4 Aug	Observing young stars	2		
6 Aug	Chemistry and thermodynamics	3	Glover et al., 2010, MNRAS, 404, 2	
11 Aug	Gas flows and turbulence	4		
13 Aug	Magnetic fields	5	Planck Collaboration 2016, A&A, 586, A138	Problem set 1
18 Aug	Gravitational instability	6		
20 Aug	Feedback	7	Kim, Kim, & Ostriker, 2018, ApJ, 859, 68	
25 Aug	Giant molecular clouds	8		
27 Aug	Galaxy-scale star formation: observations	9	Sun et al., 2018, ApJ, 860, 172	
1 Sep	Galaxy-scale star formation: theory	10		
3 Sep	Stellar clustering	11	Krumholz et al., 2018, MNRAS, 477, 2716	Problem set 2
Semester break, 7 - 18 Sep				
22 Sep	The IMF: observations	12		
24 Sep	The IMF: theory	13	Da Rio et al., 2012, ApJ, 748, 14	
29 Sep	Discs and outflows: observation	14		
1 Oct	Discs and outflows: theory	15	Kratter et al., 2014, ApJ, 708, 1585	Problem set 3
6 Oct	Protostar formation	16		
8 Oct	Protostellar evolution	17	Tomida et al., 2013, ApJ, 763, 6	
13 Oct	Massive star formation	18		
15 Oct	The first stars	19	Susa et al., 2014, ApJ, 792, 32	
20 Oct	Planet formation I (Mike Ireland guest lecture)			
23 Oct	Planet formation II (Mike Ireland guest lecture)			Problem set 4
27 Oct	Late stage stars and discs	20		
29 Oct	The transition to planet formation	21	van der Marel et al., 2015, A&A, 579, A106	
5 Nov	–			Problem set 5
Exam period, 5 - 21 Nov				

N. B. Chapter lists the textbook reading for that week, Paper is the literature paper for the presentation that week.