Chiang & Goldreich (1997)

* derive hydrostatic, radiative equilibrium models for passive disks around T Tauri stars
* assume flared disk rather than flat
* calculate the SED for the passive disk self consistently
* first assume blackbody disk
* for flat disk T\_e ~ a^(-3/4)
* hydrostatic equilibrium => flared disk
* then, drop blackbody assumption and determine the SED through radiative transfer
* assume that gas and dust temperatures are equal in the interior
* first consider flat disk, then flared
* compare with observations => the SED of GM Aur is consistent with a passive reprocessing disk

D’Alessio et al. (1998)

* accretion disk around T Tauri star taking into account accretional heating
* assume gas and dust in disk are well mixed and thermally coupled; disk receives radiation from the central star and through viscous dissipation, cosmic rays and radioactive decay
* energy transport through turbulent flux, radiation, convection
* steady state, disk geometrically thin, hydrostatic balance
* results for their fiducial model:
  + disk is optically thick to stellar radiation, but may be optically thin to its own radiation
  + temperature: for a < 5 AU, flaring not important => T ~ a^(-3/4) as in an irradiated flat disk
  + viscous dissipation is the main energy source for a < 2 AU
  + there is a disk atmosphere; there is also a temperature inversion due to stellar radiation
  + main improvement of this model is that they calculate the optical depth self-consistently rather than assume that the disk interior is optically thick
  + surface density consistent with analytic predictions
  + disk mass, timescales calculation
  + energy transport: convection only important in the midplane at a < 0.01 AU
  + gravitational stability: nonirradiated disk more likely to become gravitationally unstable at large a than irradiated disk

D’Alessio et al. (1999)

* use the disk model of D’Alessio et al. (1998) to explore how disk structure varies with alpha and Mdot
* compare with observations => models can explain near IR fluxed of T Tauri stars for disk accretion rates consistent with mean value estimates
* however, models seem to be too geometrically thick at large radii => dust settling could substantially reduce the geometric thickness of the disk => explore this in subsequent paper

D’Alessio et al. (2001)

* disk structure including dust grain growth
* still assume complete mixing between dust and gas
* find that the resulting disk models are less geometrically thick than in the case where ISM opacities are used, and they agree better with observed SED distributions

Visser et al. (2009)

* aim: understand how material changes chemically as it is transported from the molecular cloud to the star and the disk
* model the chemical evolution from the pre-stellar core to the disk phase in 2 D using a simplified semi-analytic model
* gas and dust are expected to be well-coupled => gas and dust temperatures are set to be equal
* the only chemical reactions they include are H20 and CO adsorption and desorption => total abundance of CO and H2O remains constant in each parcel
* CO and H2O begin entirely in gas phase
* Model does not include radial and vertical mixing

Disk chemistry background for thesis proposal

* from Henning & Semenov (2013):
  + mention that complex disk chemistry models have been developed by several groups and cite some literature from Table 3
  + perhaps mention that these models have shown that chemistry in disks is mostly regulated by T, rho structure, stellar / interstellar radiation fields, cosmic rays
  + some background parts from the intro can be useful for my own intro
  + disk emission from CO in its rotational transitions can be often measured due to its relatively high abundance and permament dipole moment
  + time scales of key chemical processes have to be shorter than ~1Myr => reference to Semenov & Wiebe (2011)
  + see if there’s anything relevant to mention from Table 1 (i.e. about the observed emissions from any particular molecule, perhaps from CO would be relevant)
  + abundances of discovered molecules range between ~10^-10 – 10^-4 relative to H2
  + observations find depletion of molecules relative to molecular abundances in the ISM -> caused by freeze-out or photodissociation in the disk atmosphere
  + detection of molecular ices => look at Aikawa et al. (2012, A&A 538, A57)
  + PPD’s have strong vertical and radial T and rho gradients + different radiation fields at various disk locations => diverse disk chemistry -> see summary of reactions in Table 2
    - inner disk <~ 20 AU: observed through IR spectroscopy
    - outer disk >~ 20 AU: observed through (sub)millimiter observations
  + chemistry approaches quasiequilibrium in inner disk due to high T and rho
  + for outer disk regions, high-energy radiation and cosmic rays are key drivers of chemistry; production of various ions
  + freeze-out of molecules at low T in the outer disk
  + chemical models:
    - early models: usually restricted to inner disk regions, 10-30 AU, thermodynamic equilibrium was usually assumed
  + chemical models of PPDs are based on detailed chemical kinetics models with hundreds or thousands chemical reactions => computationally intensive => decoupled from disk dynamics
  + more modern studies include various heating and cooling processes, plus grain evolution (refs 71, 98, 216, 260): 1D (ref 266), 2D approximation (ref42), X-ray radiative transport (refs 47, 52, 267, 268)
  + chemo-dynamical models: refs 207, 210, 273, 274, 275
  + more about chemistry coupled with dynamics models: Aikawa et al. (1999)… see if some references on page 9030 are worth mentioning
  + giant planets are believed to be formed outside the snowline, Kennedy & Kenyon (2008)
  + origin of water from Earth: delivered from comets, Morbidelli et al. (2010)

Semenov & Wiebe (2011)

* 2D model using the mixing-length approximation + time-dependent chemistry; for turbulent disk
* volatiles are preserved in comets
* paper about comets: Bradley (2005)
* when does turbulence affect chemistry?
  + Consider two timescales, t\_phys and t\_chem. If t\_phys < t\_chem, chemical evolution of a molecule is slow and thus sensitive to changes in the physical conditions; if t\_phys > t\_chem, chemical evolution and thus not affected by transport processes
  + Ion-molecule chemistry is very rapid, t <~ 10-1000 yr
  + Surface chemistry has a long timescale around midplane and in the outer cold regions, ~10^6 yr, larger than the turbulent mixing timescale

Cleeves et al. (2011)

* chemical model of a PPD with a large inner gap similar to those seen in classical transition disks
* radiation field: UV and X-rays; treatment of the radiative transfer in the disk
* reaction network: following Fogel et al. (2011); reaction types include photodesorption, photodissociation, freeze-out, grain surface reactions, ion and electron reactions, cosmic-ray and stellar X-ray ionization, radiative reactions

Cleeves et al. (2014)

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