Title
Digital Research: Crossing over Disciplines

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Digital Research: Crossing over Disciplines

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Wolfson College, Oxford, 13 June 2013
Data practices are local

Marie Curie's notebook

Figure 2. Numeric Change in Resident Population for the 50 States, the District of Columbia, and Puerto Rico: 1990 to 2000

http://www.census.gov/population/cen2000/map02.gif

hudsonalpha.org

Monthly Mean: f17_ssmis_201207v7.nc

http://ncl.ucar.edu

NASA Astronomy Picture of the Day

http://aip.org

http://onlineqda.hud.ac.uk/Intro_QDA/Examples_of_Qualitative_Data.php
Data practices are local

Industrial methods

Artisanal methods
Data practices are local
A role for self-gravity at multiple length scales in the process of star formation

Alyssa A. Goodman, Erik W. Rosolowsky, Michelle A. Borkin, Jonathan B. Foster, Michael Halle, Jens Kauffmann & Jaime E. Pineda

Self-gravity plays a decisive role in the final stages of star formation, where dense cores (size ~0.1 parsecs) inside molecular clouds collapse to form star-plus-disk systems. But self-gravity's role at earlier times (and on larger length scales, such as ~1 parsec) is unclear; some molecular cloud simulations that do not include self-gravity suggest that 'turbulent fragmentation' alone is sufficient to create a mass distribution of dense cores that resembles, and sets, the stellar initial mass function. Here we report a 'dendrogram' (hierarchical tree-diagram) analysis that reveals that self-gravity plays a significant role over the full range of possible scales traced by 12CO observations in the L1448 molecular cloud, but not everywhere in the observed region. In particular, more than 90% of the compact 'pre-stellar cores' traced by peaks of dust emission are projected on the sky within one of the dendrogram's self-gravitating 'leaves'. As these peaks mark the locations of pre-existing stars, or of those probably about to form, a self-gravitating cocoon seems a critical condition for their existence. Turbulent fragmentation simulations without self-gravity—even of unmagnetized isotothermal material—can yield mass and velocity power spectra very similar to what is observed in clouds like L1448. But a dendrogram of such a simulation shows that nearly all the gas in it (much more than in the observations) appears to be self-gravitating. A potentially significant role for gravity in 'non-self-gravitating' simulations suggests inconsistency in simulation assumptions and output, and that it is necessary to include self-gravity in any realistic simulation of the star-formation process on subparsec scales.

Spectral-line mapping shows whole molecular clouds (typically tens to hundreds of parsecs across, and surrounded by atomic gas) to be marginally self-gravitating. When attempts are made to further break down clouds into pieces using 'segmentation' routines, some self-gravitating structures are always found on whatever scale is sampled. But no observational study to date has successfully used one spectral-line data cube to study how the role of self-gravity varies as a function of scale and conditions, within an individual region.

Most past structure identification in molecular clouds has been explicitly non-hierarchical, which makes difficult the quantification of physical conditions on multiple scales using a single data set. Consider, for example, the often-used algorithm CLUMPFIND. In three-dimensional (3D) spectral-line data cubes, CLUMPFIND operates as a watershed segmentation algorithm, identifying local maxima in the position-position-velocity (p-p-v) cube and assigning nearby emission to each local maximum. Figure 1 gives a two-dimensional (2D) view of L1448, our sample star-forming region, and Fig. 2 includes a CLUMPFIND decomposition of it based on the 12CO observations. As with any algorithm that does not offer hierarchically nested or overlapping features as an option, significant emission found between prominent clumps is typically either appended to the nearest clump or turned into a small, usually 'pathological', feature needed to encompass all the emission being modeled. When applied to molecular-line

Figure 1 | Near-infrared image of the L1448 star-forming region with contours of molecular emission overlaid. The shades of the color image correspond to the near-infrared bands J (blue), H (green), and K (red), and the contours of integrated intensity are from 12CO(1-0) emission. Integrated intensity is monotonically but not quite linearly (see Supplementary Information), related to column density, and it gives a view of 'all' of the molecular gas along lines of sight, regardless of distance or velocity. The regions within the yellow box immediately surrounding the protostars has been imaged more deeply in the near infrared (using Calar Alto) than the remainder of the box (2MASS data only), revealing protostars as well as the scattered starlight known as 'Clouds III' and surfrooms (which appear orange in this color scheme). The four billiard ball labels indicate regions containing self-gravitating dense gas, as identified by the dendrogram analysis, and the leaves they identify are best shown in Fig. 2a. Antennas show the locations of the four most prominent embedded young stars or compact stellar systems in the region (see Supplementary Table 1), and yellow circles show the millimeter-dust emission peaks identified as star-forming or 'pre-stellar' cores.

Figure 3 | Schematic illustration of the dendrogram process. Shown is the
3. Data practices are local

Brick inscribed with the Sutra on Dependent Origination

Gorakhpur district, late 5th century-
early 6th century AD.

Ashmolean Museum


Open access to data is a paradigm shift

Industrial methods

Artisanal methods

Replication

Interpretation