

# GALAXY FORMATION: THE BOARD GAME

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**ABSTRACT.** We summarize the rules of “Galaxy Formation!”, a board game, and describe the course of the game played at the end of the conference.

## 1. Overview of Rules

The game action takes place a few years in the future, beginning with the flight of Space Telescope. Each player (or collaboration thereof) chooses a theory for the formation of galaxies, large-scale structure, and everything else that matters. Currently, the available choices are: cold dark matter (biased, with  $\Omega = 1$ , and open, with  $\Omega = 0.2$ ), explosions, cosmic strings (non-superconducting), cosmic strings (superconducting), isocurvature baryons, massive neutrinos, and primordial magnetic fields. A player may represent himself or may choose to assume another “persona”, whose style, mannerisms, and theoretical prejudices should guide his play. Persona Icons (caricatures) of a number of eminent astrophysicists are provided with the game. The object of the game is to acquire enough Plausibility Points to have one’s theory declared the one true and correct theory of galaxy formation.

The game board is divided into five Observational Areas: galaxy properties (masses, morphologies, rotation curves), galaxy clustering (covariance function and other clustering statistics), very large scale structure (cluster correlations, large-scale velocity flows, giant voids and superclusters), high redshift observations (galaxy evolution, high- $z$  galaxies, quasars, Lyman- $\alpha$  clouds), and the microwave background. Each Observational Area contains Paper squares, and a player who lands on one may submit a paper explaining observations in that area in the context of her theory. If accepted (rapid refereeing is ensured by rolling the die), the paper earns plausibility points, the exact number depending on whether the Observational Area is a strength or weakness of the theory in question. Moving about the game board, players must avoid such perils as computer errors that swallow six months of work (and one turn), appointment to presidential blue-ribbon panels (one turn), and triplets (three turns), while angling to acquire superb graduate students (extra turn), or Macarthur fellowships (five years of funding).

The quest for plausibility points may be advanced or hindered by Observational Developments. When a player lands on an Observational Development space, he draws an Observational Development card. Each card has two possibilities (e.g. microwave background fluctuations are detected or new limits are set on fluctuations), and the one that appears right side up in the shuffled deck applies. The effects on the plausibility of different theories are listed on the card, although a player may attempt to persuade the others that an observational development

should affect his theory in some other way. In addition, each player may choose to ignore **one** observational development during the course of the game.

Other essential aspects of the scientific endeavor have been included in the game. Players who exhaust their funding must spend their turn writing grant proposals and spin the Funding Spinner to determine the term (if any) of the grant awarded. Whenever two players land on the same space, they have the option of forming a Scientific Organizing Committee and calling a conference. This requires all other players to join them on the board, but the conference organizers lose their next turn while they edit the proceedings. A Hubble Spinner is provided for observational determinations of the Hubble constant.

A player may acquire enough plausibility points to win the game outright — winning in this way requires many papers and a remarkable string of good luck with the observations. Alternatively, after acquiring a lesser number of plausibility points a player may attempt a Consensus Win. She is given two minutes to explain why her theory should be declared the one true and correct theory of galaxy formation. Other players have one minute to discuss the question, after which they vote secretly. If there are at least two no votes, the attempted win fails. If all votes are yes, the attempted win succeeds. If there is only one no vote, the win also succeeds. The lone dissenter is branded as a quack, doomed to a life of writing papers that no one else believes and hearing whispers about “what a good theorist he used to be.”

Short Game rules are provided for dilettantes who lack the energy and perseverance to resolve the issue of galaxy formation in the proper way. A Short Game lasts for a fixed period of six fiscal years, after which the two players with the highest plausibility scores are eligible to win. Each has two minutes to argue why he should be declared the victor. The winner is then decided by a majority vote.

## 2. The Durham Game

Fortified by a week of scientific discussion, a fine Indian dinner, and fuel from the college pub, several conference participants gathered for a Friday night game. Personae and theories were chosen up as follows (we identify the actual players by initials only, in order to maintain a false illusion of anonymity): Ostriker (CAT) and Zel’dovich (JEG) defended explosions. Burbidge (DNS) and Schmidt (AB) united behind primordial magnetic fields. White (NRT) and Geller (ELZ) adopted cold dark matter. Peebles (PJEP) took isocurvature baryons. Both flavors of cosmic strings were advocated, non-superconducting by Rees (RHB), and superconducting by Witten (JEB). Gott (TRL) and Silk (CGL) supported massive neutrinos. Efstathiou (NSK) played the Skeptic, an irritating character who defends no theory of his own but writes papers that negate other player’s papers.

Gott and Silk quickly won lucrative TV and book contracts, so they retired early from astronomy (and the game) to a life of fame and fortune. Peebles, once his term as Ap J editor was up and his papers had to be refereed again, followed suit. Efstathiou was a generally ineffective skeptic, but he did manage to savage cold dark matter on several occasions. Rees lost three turns finding a job, after his department was shut down.

Cold dark matter acolytes were cheered by several Observational Developments: dwarf galaxies were found in voids, disk galaxies were shown to be rare at  $z > 1$ , the Great Attractor “faded away”, and, most dramatically, photinos were discovered. Despite the troubling observation of two  $z > 6$  quasars, cold dark matter seemed well poised to win the game. In the end, though, it was Witten and superconducting cosmic strings that carried the day, largely on the basis of the gravitational wave background (detected by timing studies of millisecond pulsars), some creative paper titles, and a better performance in the final conference. However, since this game was played under the Short Rules instead of the Knock-Down Drag-Out Rules, the outcome cannot be considered definitive.