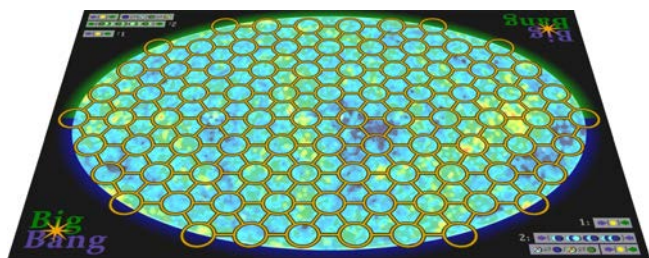


Big★Bang

The fate of the Universe in the hands of 2 players



A second after the Big Bang, the matter and antimatter that had just been created annihilated into light. Hopefully, a tiny excess of matter survived, about 1 particle per billion, providing the building blocks of the Universe we live in. Find your antiplayer and re-fight that clash between matter and antimatter. Physics is the only rule!

OVERVIEW

A **Big★Bang** box includes:

- 1 board.
- 1 annihilation token ★.
- 84 ‘particles’ or discs, 21 of each in 4 colors:

● = protons	} matter
● = neutrons	
● = antiprotons	} antimatter
● = antineutrons	

The board represents an elongated and irregular hexagonal grid with 84 circles, on which the particles will be placed. The background picture evokes the cartography of the temperature difference in the “cosmic microwave background”, the light flash that followed the annihilation of matter and antimatter, measured by the WMAP satellite.

Both players fill the board randomly with the 84 particles, trying to distribute them homogeneously, and then the **elder** player takes the ★ token and chooses to be the:

- **Player**, using **matter** (● & ●).
- **Antiplayer**, using **antimatter** (● & ●).

Sit on your respective sides of the board (*top for the antiplayer on the picture*). You should avoid direct contact, if you don’t want to annihilate! The **younger** player starts.

Player and antiplayer alternate turns trying to fuse their particles (*discs*) in order to form the **highest piles**.

But during the game you will also need to annihilate them, and even make them decay!

NUCLEI

The proton (●) is the nucleus of most natural Hydrogen. As a nucleus it is called “ ^1H ” (*the number of particles followed by the symbol*), but the laws of Physics let it combine with more protons and neutrons in order to form other **composite nuclei** (*piles of discs in the game*), which can exist in their version of matter and antimatter:

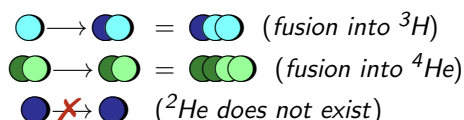
name	element	matter	antimatter	height
^2H	Hydrogen	●●	●●	2
^3H	Hydrogen	●●●	●●●	3
^3He	Helium	●●●	●●●	3
^4He	Helium	●●●●	●●●●	4

The name of the antimatter version is usually preceded by “anti” (*for example* ●● = *anti* ^2H), but in the following we may often use the same name for simplicity. All other combinations are **forbidden**! So only those four piles can be formed, of heights 2-3-4, in their two versions. Protons and neutrons are considered piles of height 1.

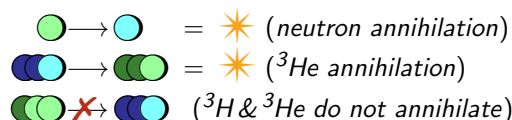
ACTIONS

The 84 particles start alone on their circle, but during the game they can combine, disappear or even transform, as the result of these three actions:

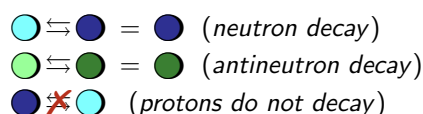
1. **Fusion** of your piles. Move a pile of yours to an adjacent circle, or along a straight line of empty circles, and place it on top of another pile of yours. Of course, you cannot fuse into forbidden combinations:



2. **Annihilation** of opposite piles. Move a pile of yours to an adjacent circle, or along a straight line of empty circles, towards exactly the **same** equivalent pile of your opponent. Remove the discs of both piles from the board and keep them aside as a reserve:



3. **Decay** of the neutron (● & ●). Choose any one neutron alone in a circle and replace it with its corresponding proton from the reserve generated by annihilation, **only if** that proton were available:



The ★ token **changes** hands every time the player not owning it annihilates **composite** piles (*of heights 2-3-4*).

TURN SEQUENCE

Each turn is composed of **two actions**:

1. A first action to choose from:
 - **Annihilation** (of opposite piles).
 - **Decay** (of the neutron).
2. A second action to choose from:
 - **Annihilation** (of opposite piles).
 - **Fusion** (of your piles).

Both actions are mandatory, you **cannot pass**! You will find reminders of the turn sequence on the board corners.

At the beginning, the first actions will have to be Annihilation, but as soon as protons become available you will be able to use Decay if needed. The second action will mostly be Fusion, the aim of the game, although sometimes you may want to use Annihilation again, you will see!

END OF THE GAME

The game ends immediately as soon as one of the players **cannot** take an action.

The player with more piles of **height 4** (${}^4\text{He}$) wins!

In case of draw, victory goes to the player having, following this order, the first of these things:

- More piles of **height 3** (${}^3\text{H}$ and ${}^3\text{He}$).
- More piles of **height 2** (${}^2\text{H}$).
- The annihilation token \star .

Will **matter** prevail over **antimatter** this time?

SOLITAIRE PUZZLES

If you want to enjoy **BigBang** on your own, we propose the following puzzles. In all of them set up the game as usual, but now there are no matter and antimatter turns! Just keep choosing **Fusion** or **Annihilation** of any type of pieces, until you cannot or do not want to. There are three 'universes' of increasing difficulty:

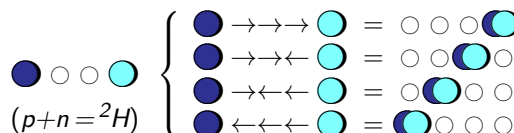
1. **Universe of Light.** Annihilate all the particles. Your (*negative*) score: the particles left on the board.
2. **Parallel Universes.** Create stars (*groups of piles*) of matter and of antimatter separated by at least one empty space with the minimum Annihilation possible. Your (*negative*) score: the annihilated particles.
3. **Universe of Life.** Create Carbon and antiCarbon nuclei (*groups of three contiguous ${}^4\text{He}$ or anti ${}^4\text{He}$, in any shape*). Carbon, the basis of life, is in fact created inside stars by this reaction, the 'union' of three ${}^4\text{He}$. Your score: the total number of Carbon and antiCarbon groups (*maximum of 6*).

DARKNESS VARIANT

During setup, replace 1 particle of each type with any 4 tokens at hand (*small cubes, coins...*). They represent **dark matter**, that does not interact with the particles on the board. Treat them as fixed obstacles that block the movement towards Fusion or Annihilation.

GRAVITY VARIANT

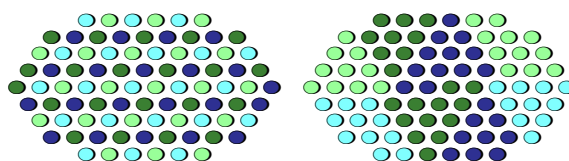
When you use **Fusion**, you may move **both** piles towards each other, and choose the location of the fused pile along the line defined by the two initial circles:



ALTERNATIVE SETUP

If you don't want to start with a random setup, we suggest two alternative options:

1. **Symmetry.** Set up the discs so that there is matter/antimatter symmetry, as in these examples:



2. **Choice.** The elder player starts placing a particle of each type in any 4 empty circles. The younger player does the same in return, and they keep alternating this procedure until the board is full.

A BIT OF PHYSICS

In this game we mix two events that actually happened: the annihilation of matter and antimatter, which we believe happened in the first moments of the Universe; and the primordial synthesis of Hydrogen and Helium from the matter that survived, which extended to the first minutes. Thus we propose a race between two syntheses, Hydrogen/Helium on one hand and anti-Hydrogen/anti-Helium on the other, among the annihilations.

So is this game science... fiction? Maybe not! Today we are still searching for areas in space where some of the original antimatter could have survived. We try to detect radiation composed of antiparticles, which would have been emitted by antistars, perhaps surrounded by antiplanets... forming part of an antigalaxy!

Finally, the neutron is not the only unstable pile in the game, ${}^3\text{H}$ is also unstable (*it eventually decays to become ${}^3\text{He}$*). However, its half-life is about 12 years, so during the few minutes of the game it can be considered stable to all purposes, without further complicating the rules.