

The INFN Game Project



Antonio Sidoti

INFN Sezione di Bologna

On behalf of the GAME project

Trieste – 26th June 2026



Istituto Nazionale di Fisica Nucleare

\$ whoami

My name is Antonio Sidoti

Staff researcher at Istituto Nazionale Fisica Nucleare (INFN) – Sezione di Bologna

Experimental Particle Physicist

Mainly physics at hadron colliders

→ ATLAS experiment at CERN:

Main Research Interests: Beyond Standard Matter searches (heavy Majorana neutrinos), Tracker upgrade

Mail: antonio.sidoti@bo.infn.it
antonio.sidoti@cern.ch

Project web site under construction: <https://web.infn.it/game/>

INFN Webcollision site: https://collisioni.infn.it/attivita_educative/infn-game-giochi-fisica/

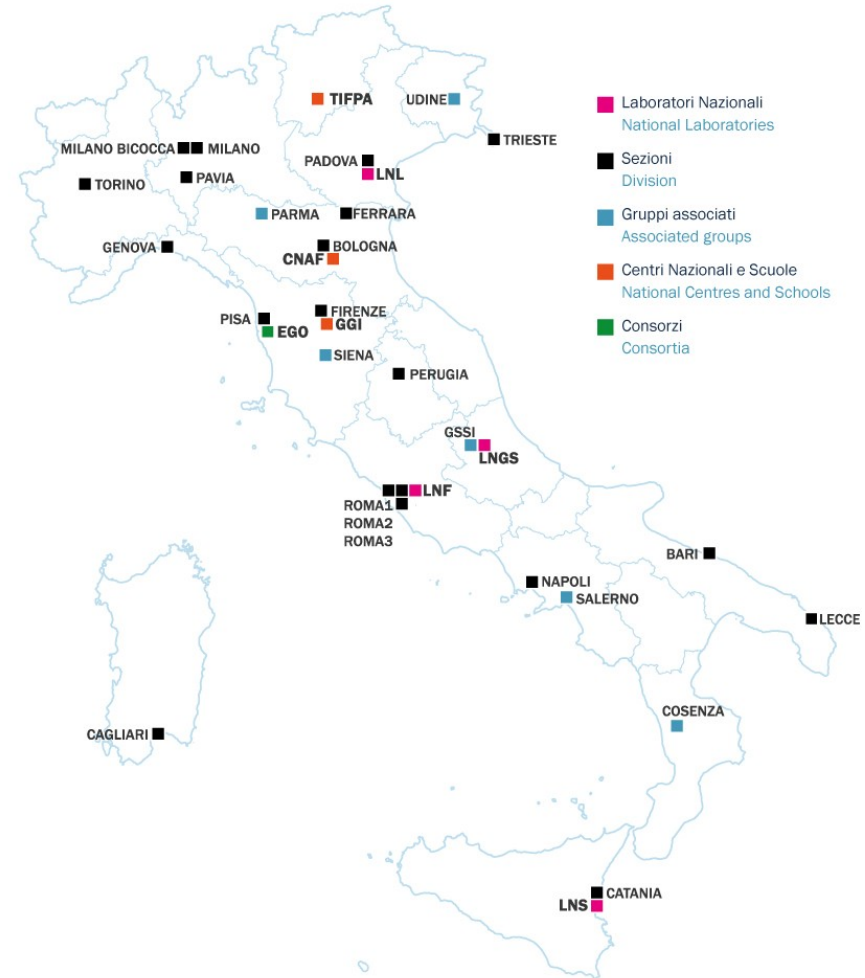


INFN

A research organization dedicated to the study of the fundamental constituents of matter and the laws that govern them. It carries out theoretical and experimental research in the fields of subnuclear, nuclear and astroparticle physics.

Founded on 8 August 1951
approximately 2,000 employees and
3,600 associates

20 Sections and 4 Laboratories
National (Catania, Frascati,
Gran Sasso and Legnaro)





INFN Public Engagement and Dissemination

Since 2018, the INFN has had a Third Mission Coordination Committee focused on Public Engagement and Dissemination

- Dedicated budget
- ~20 projects funded at national level, with an internal review system
- Diversify audience (age, general public vs schools)
- A commitment to reach as wide an audience as possible, both in terms of age (e.g. secondary schools other than science-focused colleges) and geography (e.g. activities in remote locations and/or disfavored regions such as Lampedusa)

A bit of History ...



2022: First time INFN stand at PLAY fair (Modena)



2023-2024: Several INFN branches expressed interest to participate at the PLAY fair (and ERN)



2024: Scientific Game Design INFN internal tutorial



2025: Spinning activity between the project and festival



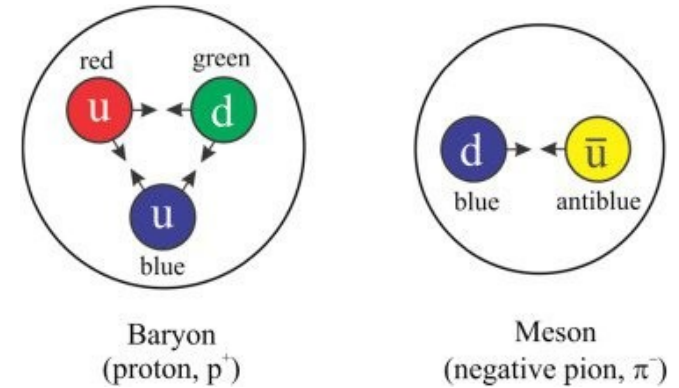
2026: Selling the first box of "I Primi 20 Minuti" at the PLAY fair

1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 26

The laws of physics are “rules of a game” to being adapted into the ‘rules’ of a board game. We must be careful not to trivialize the subject or present an overly simplistic idea as if it were true

Communicating how research is conducted, particularly in the world of large-scale collaborations ‘Management’ games are a classic genre within board games, and their dynamics lend themselves perfectly to the vital task of explaining how research is conducted (especially when funded by public money!). In this case, care must be taken to avoid conveying an overly competitive view of research, one that is too focused on funding.

cf R. Blanos presentation this afternoon



What have been done so far?

Adapting physics content on existing, well-known games:

Guess the Radionuclide—based on **Guess Who** and created as part of the Radiolab project



Un gioco radioattivo
per i fisici del futuro!



UNIVERSITÀ
DEGLI STUDI
DI MILANO



Mesopoly—**Monopoly** in the world of quarks: developed in collaboration with Galvani High School in Bologna



Cosmic Time Travel—based on **Timeline** focus on the story of cosmic rays

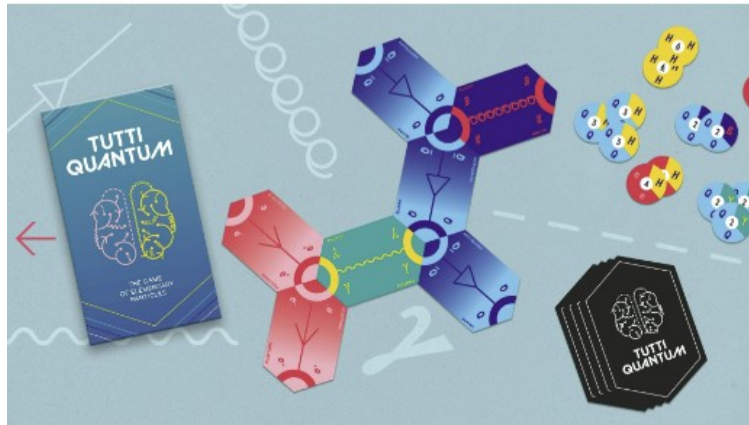
Space Route—based on **Carcassonne**, it introduces players to satellite design

Pros: rules are already known → Play immediately

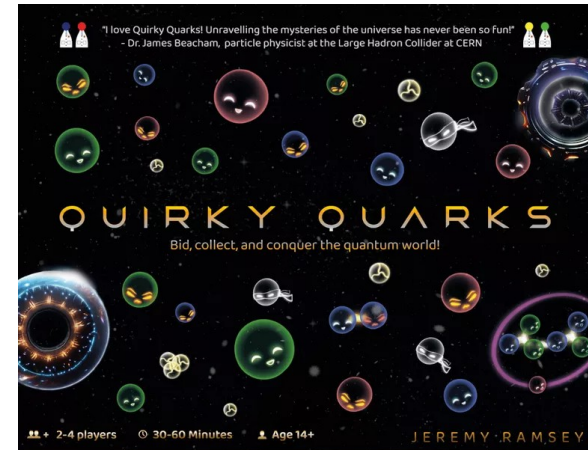
Cons: Sometimes the scientific contents looks ancillary (lack of originality)

There are also many games designed professionally and published and distributed commercially

Tutti Quantum from Helvetiq



Quirky quarks

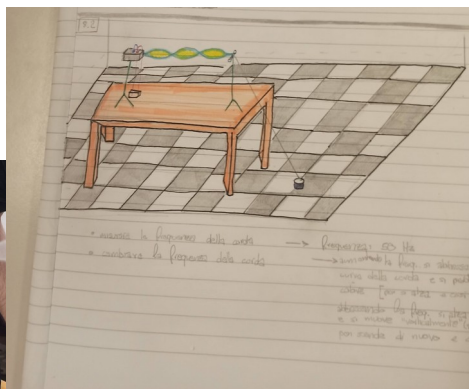


And many others→ Look for “Theme: Physics” in boardgamegeek web site

and roleplaying games

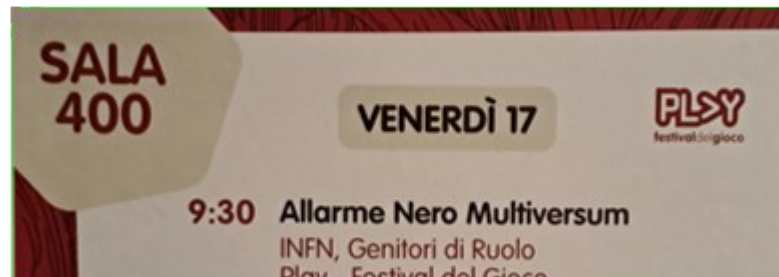
Research Simulator

Focused on how scientific research is performed



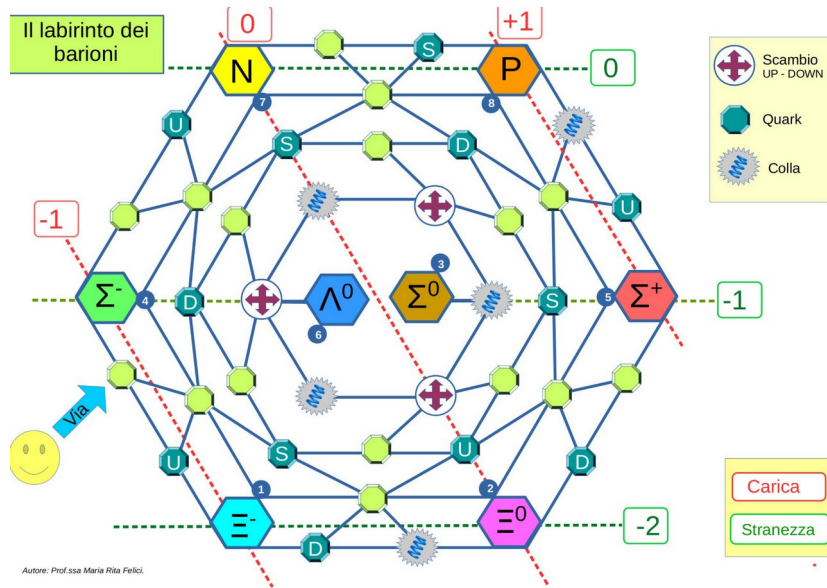
ANNO 2022		RESEARCH SIMULATOR		INFN	
NAZIONI E FINANZIAMENTI		ESPERIMENTI PROPOSTI			
ITALIA	\$\$\$	METTERE UN ALTRO SFONDO	\$\$\$\$		
FRANCIA	\$\$\$	CAMBIARE LA FREQUENZA	\$\$\$\$\$\$		
GERMANIA	\$\$	FARE UN VIDEO AD ALTI FPS	\$\$\$\$\$\$\$\$		
REGNO UNITO	\$\$	RIFARE SOTT'ACQUA	\$\$\$\$\$\$\$\$		
SVIZZERA	\$\$\$	ILLUMINARE CON LED CELLULARE	\$\$\$\$\$\$		
SPAGNA	\$\$\$	MISURARE LA FREQUENZA	\$\$\$\$		
TEORIE PROPOSTE		COLORI COMPLEMENTARI/OPPOSTI			
		BATTIMENTI			
		ILLUSIONE OTTICA			

Multiversum Alert (at PLAY 2024) developed in collaboration with the Genitori di Ruolo association)



Games developed so far

Baryon Labyrinth. Collect quarks with right color and build the various hadrons

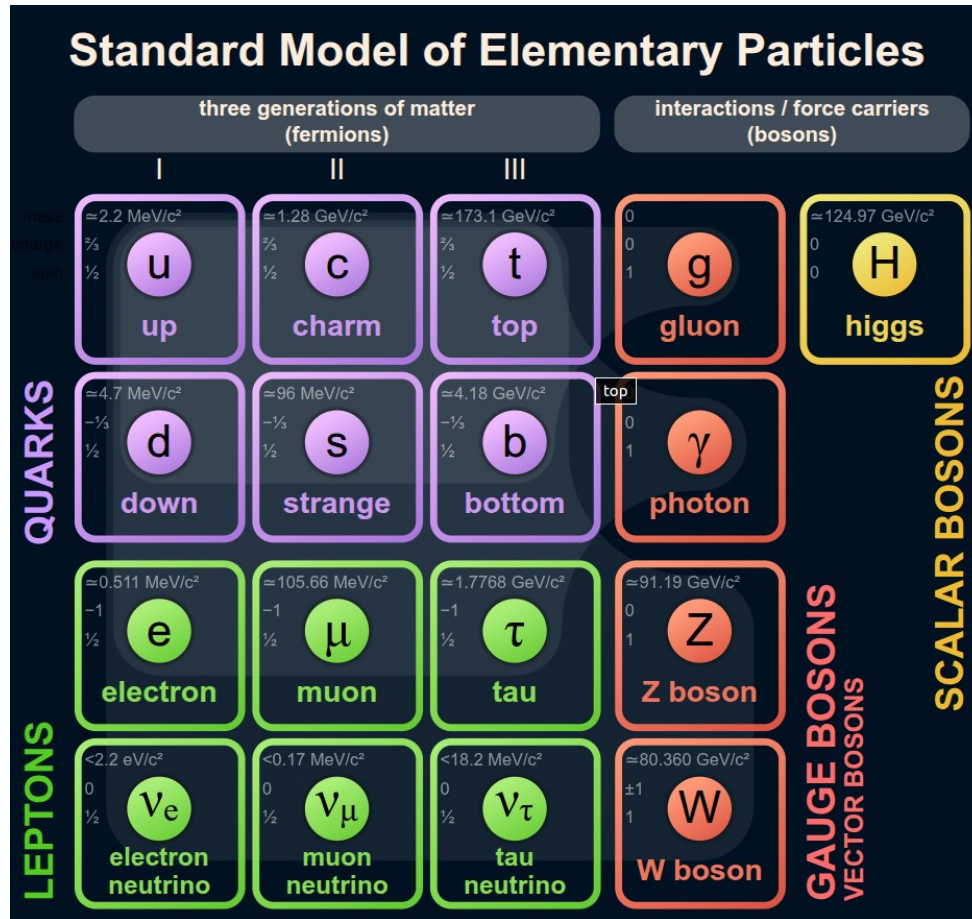


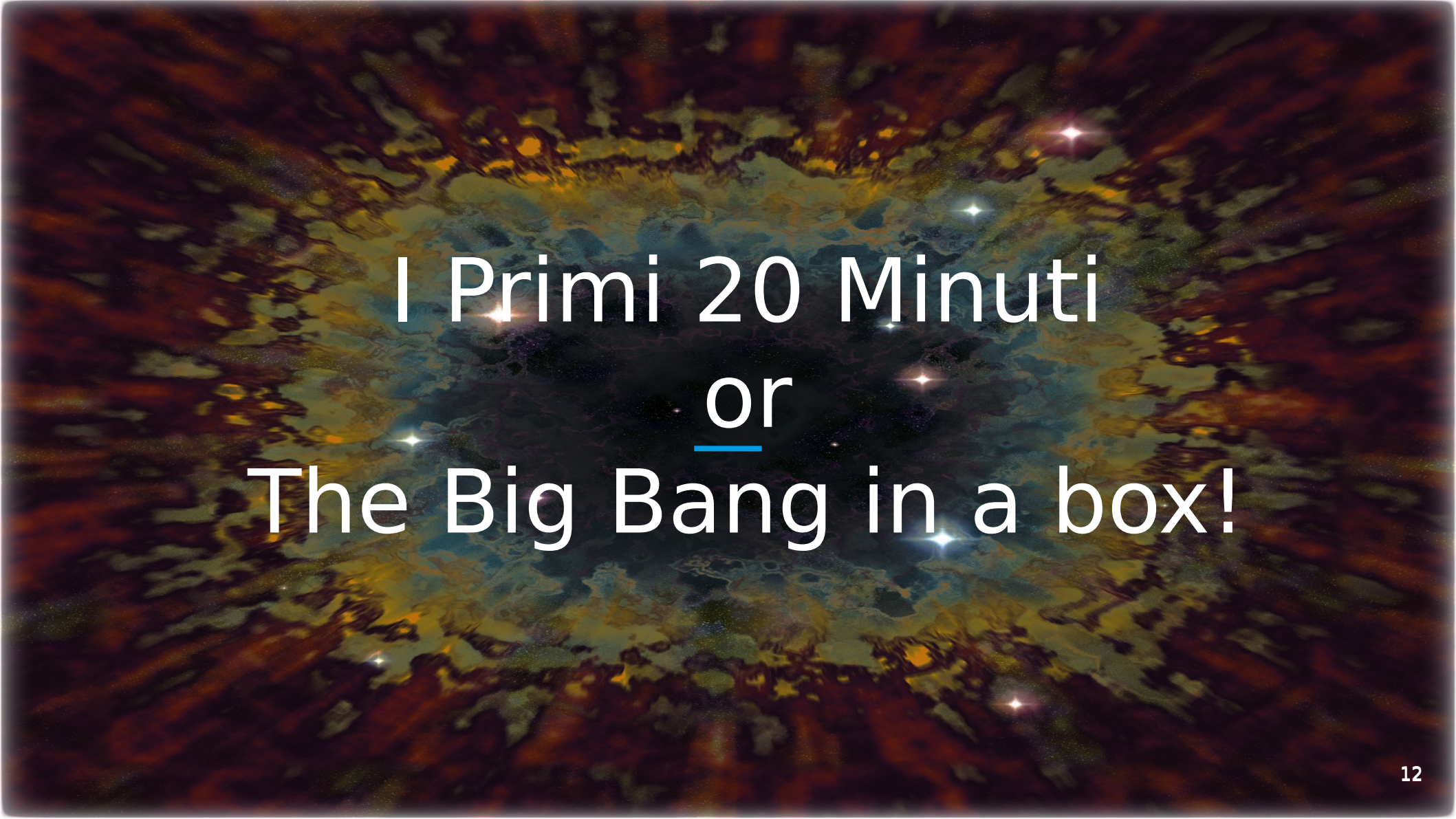
- **Poweri Noi! Watt should we do** → cf Simone Restelli's talk on Tuesday
- **I Primi 20 Minuti** → Inspired by primordial nucleosynthesis
- **Neutrino's chess** → Chess-like game dealing with neutrinos oscillation
- **Hep Card** → Card game exploring how the Standard Model particles couple (bosons with fermions)

Pros: Game mechanics are inspired by the physics content we want to point. Can have different level of complexity

Cons: Learning curve of the game can be steep and more challenging (too much out of comfort zone?)

The Standard Model of Particles



The background of the slide is a detailed map of the Cosmic Microwave Background (CMB) radiation. It shows a complex pattern of temperature fluctuations across the sky, with colors ranging from dark blue (cooler) to yellow and red (warmer). Several bright, star-like spots are visible, representing specific regions of interest or anomalies in the radiation field.

I Primi 20 Minuti or The Big Bang in a box!



Credits

Game designers: Fabrizio Parodi and Carlo Schiavi University of Genova and INFN

Consultants on Game Design: Carlo A. Rossi and Tommaso Montanari (Professional Game Designers)

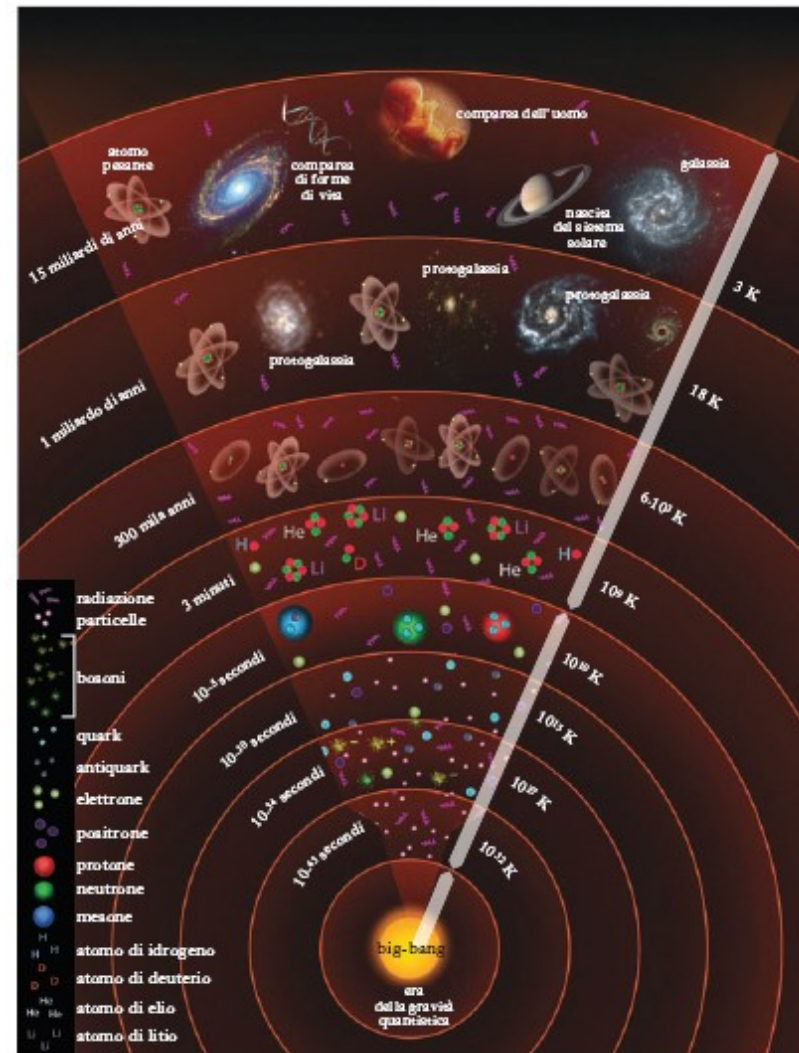
Feedback and Play Testing: Jacopo Pinzino, Luca Morescalchi, Antonio Sidoti and many other participants of the GAME project (INFN)

Graphic design: Maurizio Toccafondi (Scuola Internazionale di Comics - Firenze)

100

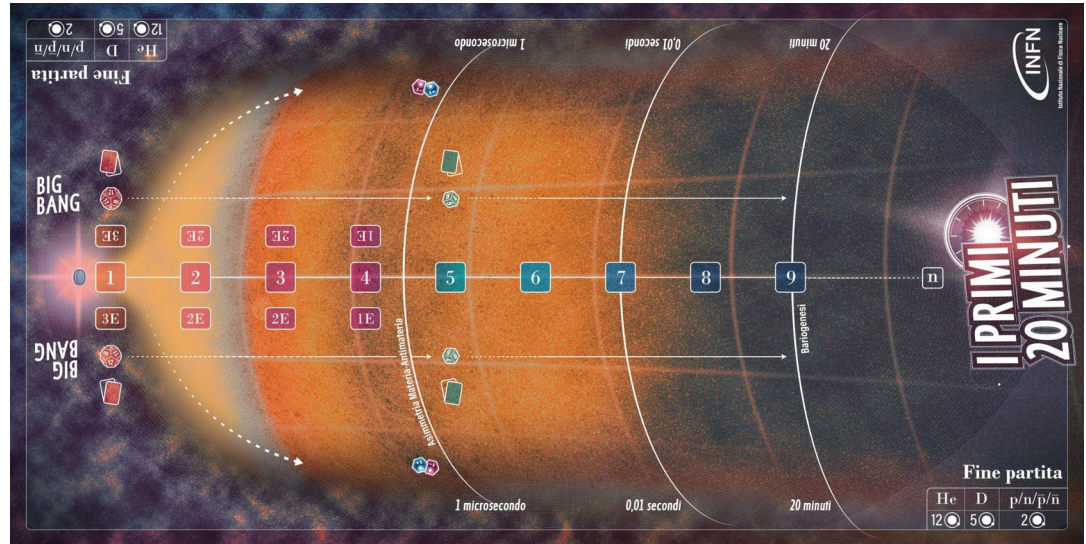
Focusing on the first minutes of life of the Universe without using a classic seminar

→ Include the physics message in the game mechanics of a board game



Game structure

- “roll & write” game
- Eurogame (or german game).
- Base mechanics: resource to move
- The game is played in simultaneous turns.
- Resources (particles and energy) are determined by dice rolls common to all players (personal objectives assigned at the start of the game differentiate players' strategies)
- Up to the 4th turn: matter-antimatter symmetry → on average, players receive as many particles as antiparticles. From the 5th turn onward: players receive only particles
- Scoring: at the end of the 4th turn (majority of particles or antiparticles), at the end of the game (when the first helium nucleus is created).





“I primi venti minuti” in short

"I primi venti minuti" is a strategic boardgame that recreates primordial nucleosynthesis. Organize particles and energy to build your expanding universe

*Caution: the first player that creates the Helium nuclei triggers the end of the game, but victory is not guaranteed!
The winner is the player that optimized the resources creating the richer universe.*



Game Levels

Short:

The universe has all the interactions. Players should concentrate on managing resources (quarks and energy) [duration ~ 20 minutes]



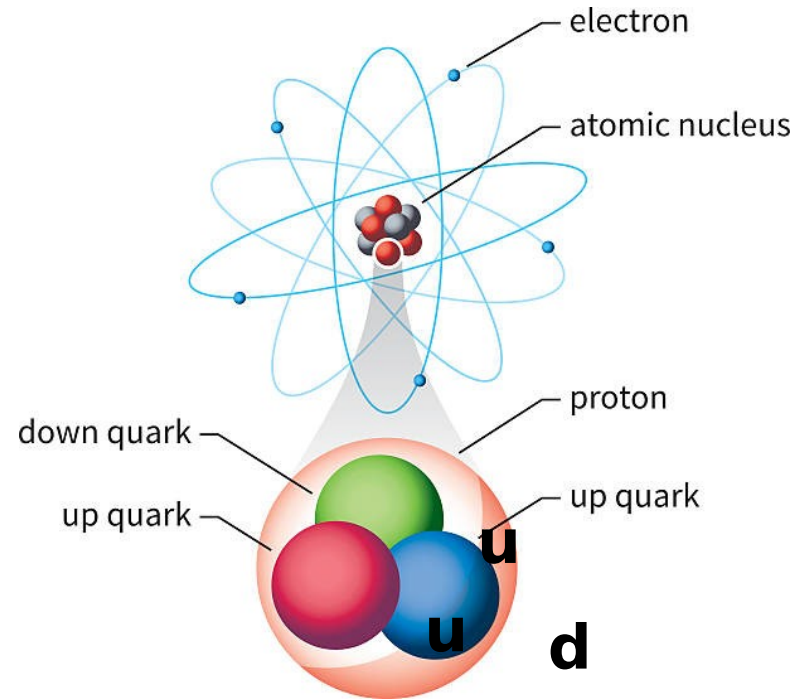
Long:

Players should dress their universe with fundamental interactions modifying the universe evolution. Richer interactions between players [duration ~ 40 minutes]



What message we want to pass?

Composition of matter



Quarks are the fundamental constituents of:

- Protons (**p**): **u+u+d**,

- Neutrons (**n**): **u+d+d**

Quarks have an additional degree of freedom “color”
red, **green** and **blue**

Light nuclei

- “Protium” (most common Hydrogen isotope): **p**

Deuteron (Hydrogen isotope): **p+n**

- Helium (He): **p+p+n+n**

There are antiparticles too!

Anti-particles are identical to particles but with an opposite electric charge

electron e^- / positron e^+

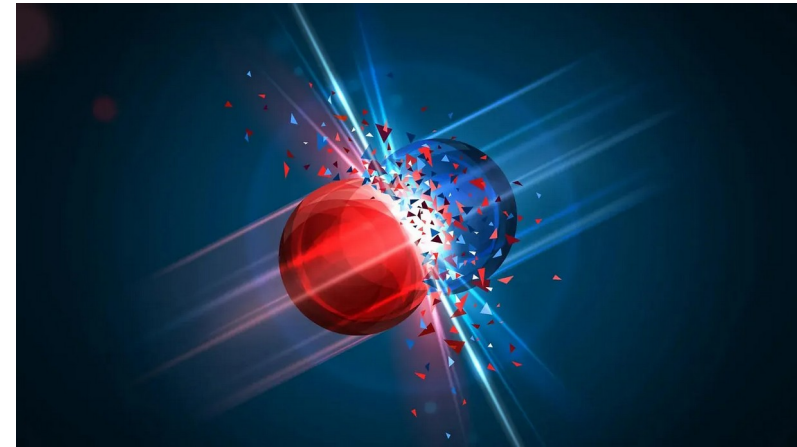
quark u / anti-quark $\bar{u}$

quark d / anti-quark $\bar{d}$

proton uud / anti-proton $\bar{u} \bar{u} \bar{d}$

neutron udd / anti-neutron $\bar{u} \bar{d} \bar{d}$

Particles and antiparticle annihilate producing energy



Fundamental Forces

Strong Force

Binds quarks in protons and neutrons.
Allow color change in quarks

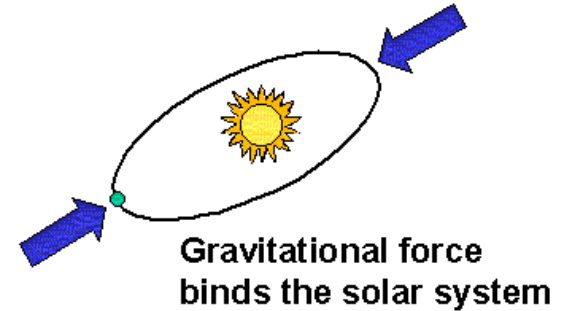
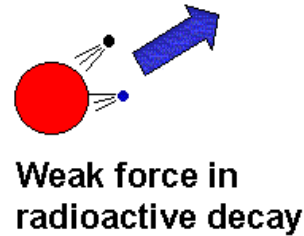
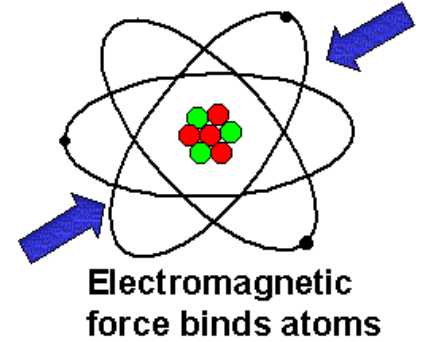
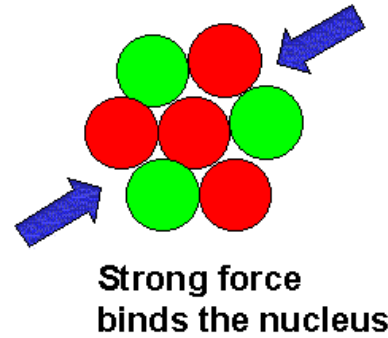
Electromagnetic Force

Binds electrons to nuclei to build atoms.
Creates energy through annihilation
particle-antiparticle.

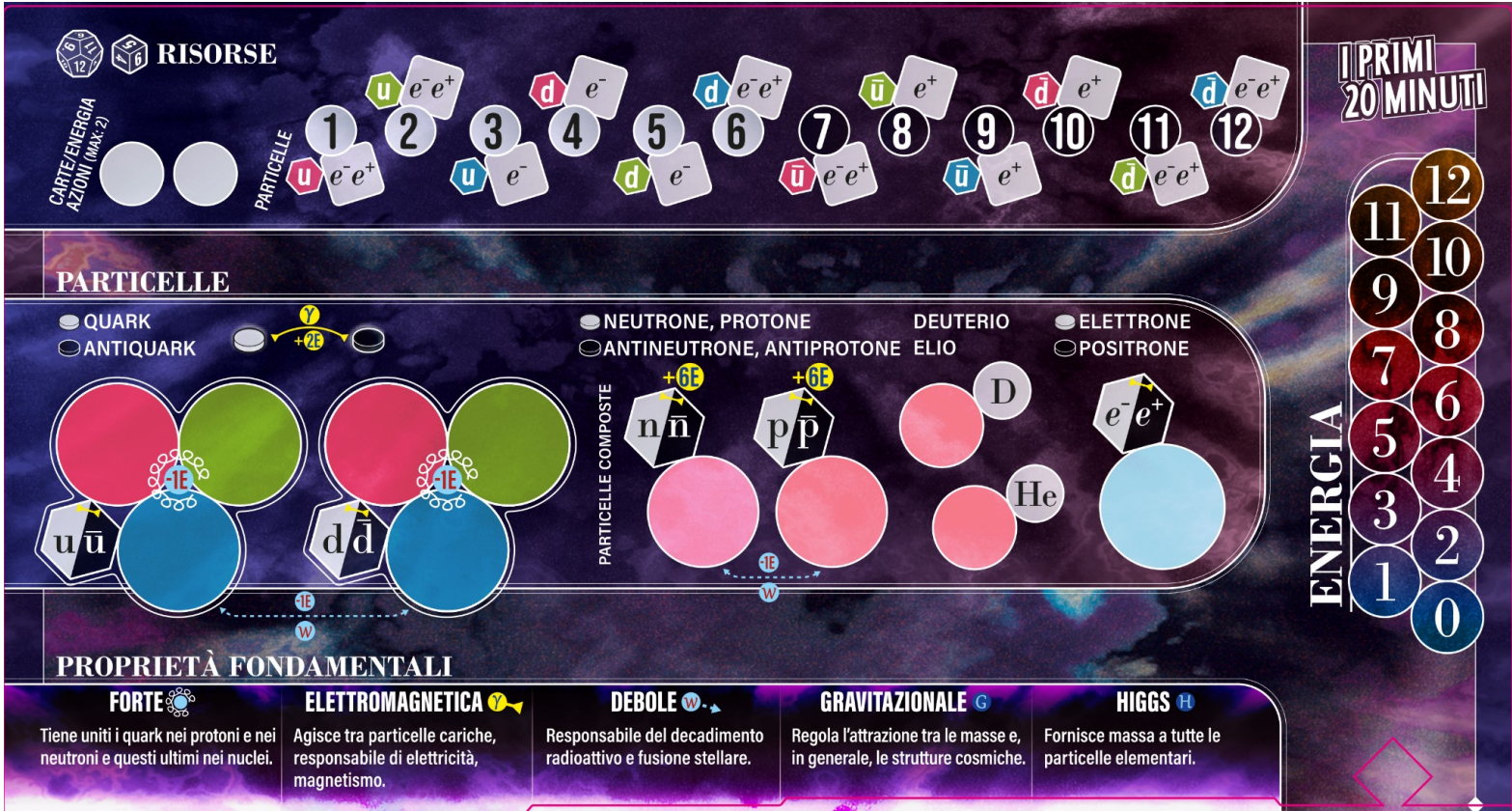
Weak Force Forza debole

Allows transformation neutron $\leftrightarrow$ proton
and quark $u \leftrightarrow d$

Gravitational Force (only in the
advanced version of the game)

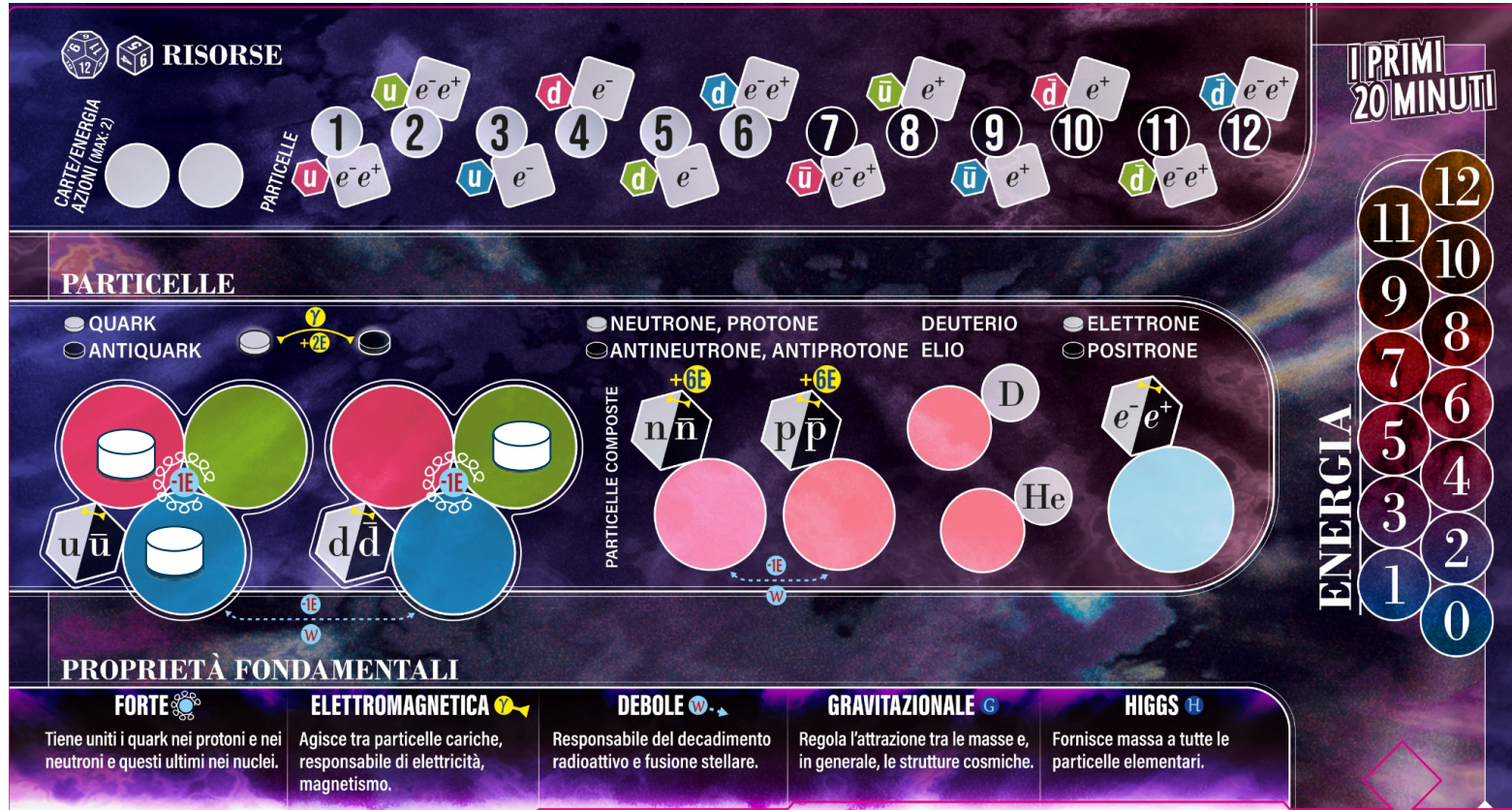


Physics acts as Game Mechanics



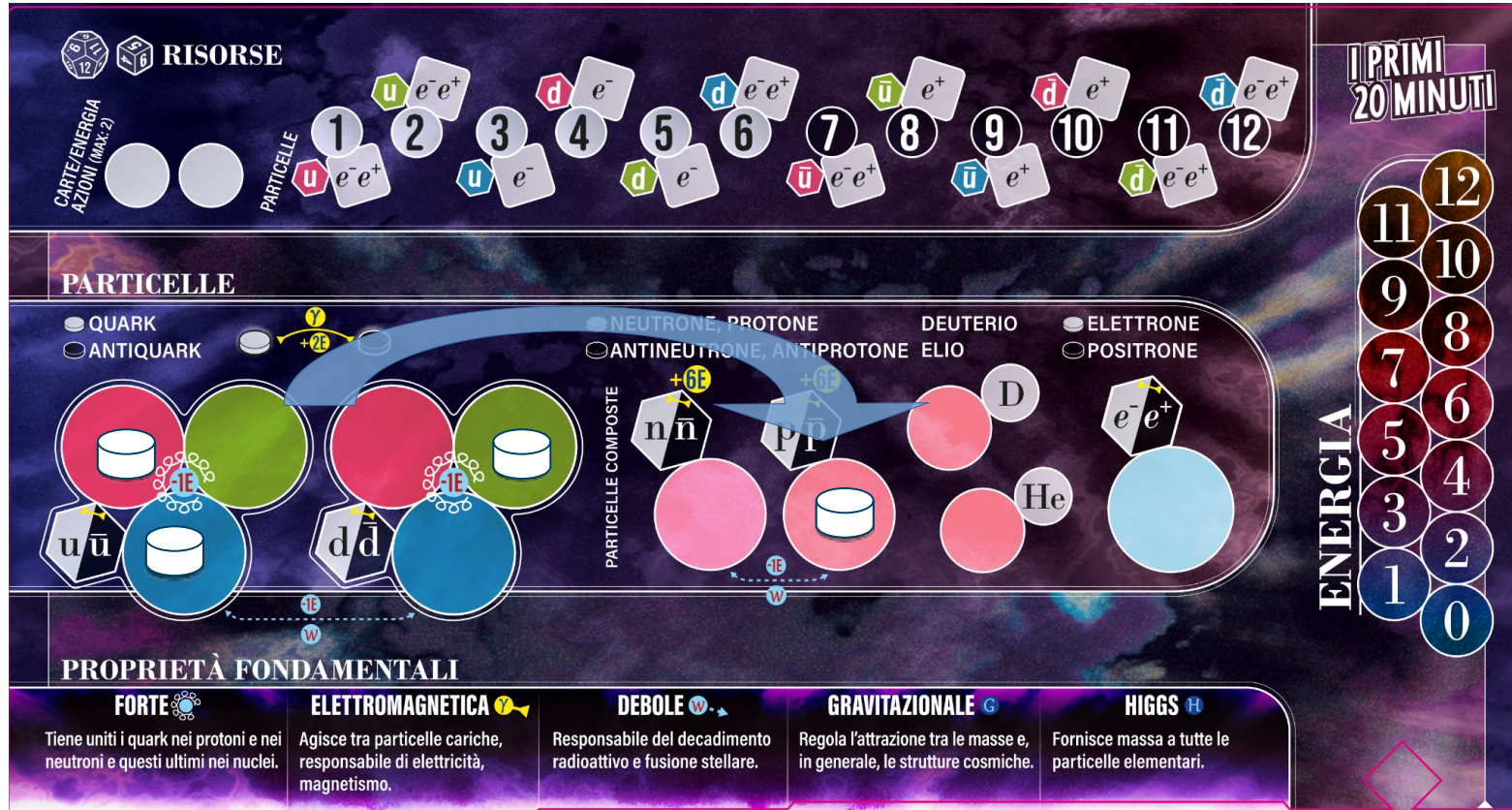
Protons and neutrons are built combining their quark constituents
(quarks have “hidden” degrees of freedom → Color → Quantum
Chromodynamics (QCD)

Strong Force



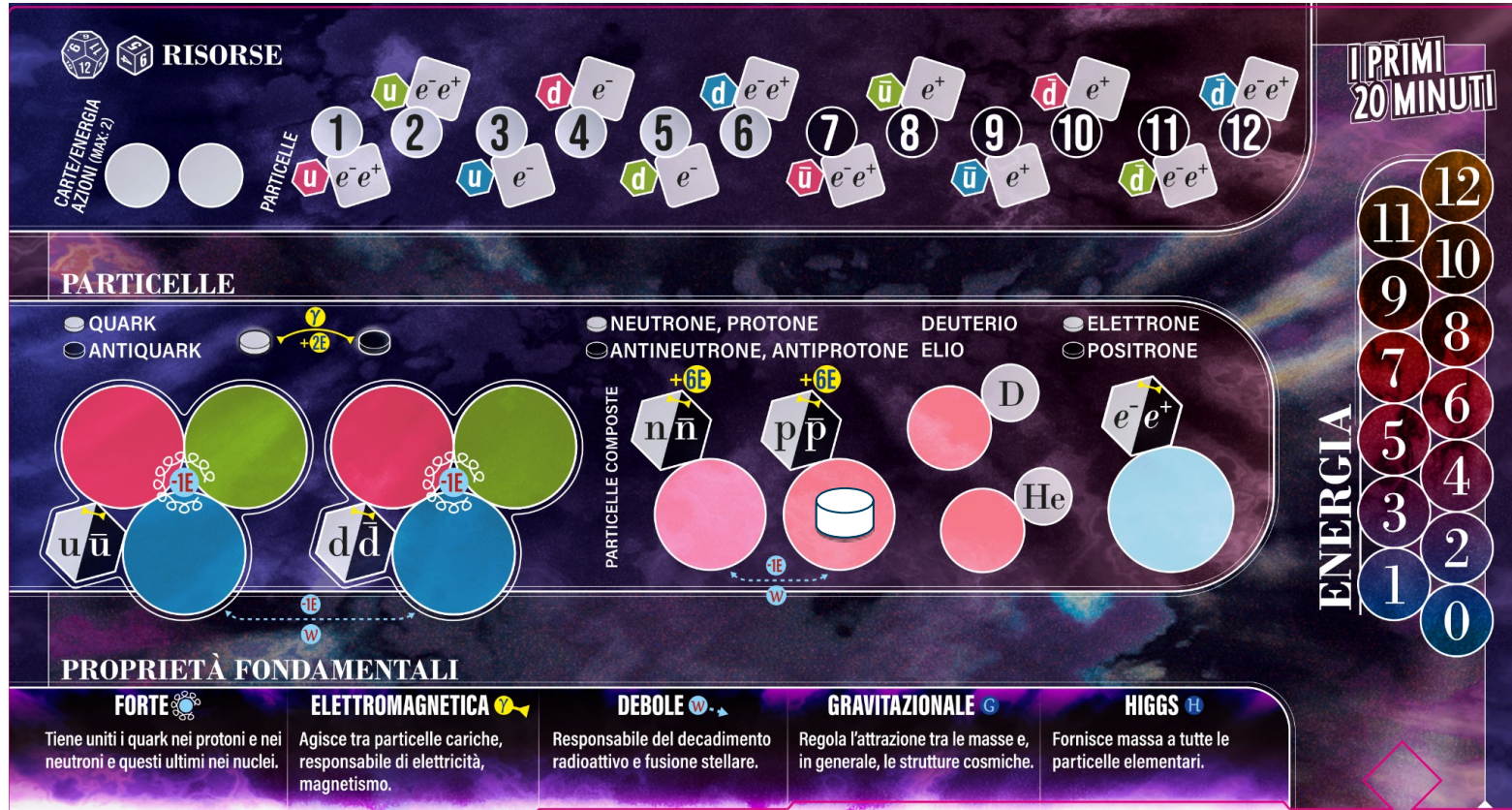
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Strong Force



Protons and neutrons are built combining their quark constituents
(quarks have “hidden” degrees of freedom → Color
→ Quantum Chromodynamics (QCD)

Strong Force



Change quark color

Strong Force

RISORSE

CARTE/ENERGIA AZIONI (MAX: 2)

PARTICELLE

1 2 3 4 5 6 7 8 9 10 11 12

PARTICELLE

● QUARK
● ANTIQUARK

● NEUTRONE, PROTONE
● ANTINEUTRONE, ANTIPROTONE

DEUTERIO ELIO

● ELETTRONE
● POSITRONE

PROPRIETÀ FONDAMENTALI

FORTE

Tiene uniti i quark nei protoni e nei neutroni e questi ultimi nei nuclei.

ELETTROMAGNETICA

Agisce tra particelle cariche, responsabile di elettricità, magnetismo.

DEBOLE

Responsabile del decadimento radioattivo e fusione stellare.

GRAVITAZIONALE

Regola l'attrazione tra le masse e, in generale, le strutture cosmiche.

HIGGS

Fornisce massa a tutte le particelle elementari.

ENERGIA

11 10 9 8 7 6 5 4 3 2 1 0

I PRIMI 20 MINUTI

Change quark color

Strong Force

RISORSE

CARTE/ENERGIA AZIONI (MAX: 2)

PARTICELLE

1 2 3 4 5 6 7 8 9 10 11 12

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ENERGIA

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I PRIMI 20 MINUTI

Change quark flavor $u \leftrightarrow d$, or $\bar{u} \leftrightarrow \bar{d}$

Weak Interactions
(weak neutral currents)

RISORSE

CARTE/ENERGIA AZIONI (MAX: 2)

PARTICELLE

1 2 3 4 5 6 7 8 9 10 11 12

PARTICELLE

● QUARK
● ANTIQUARK

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HIGGS

Fornisce massa a tutte le particelle elementari.

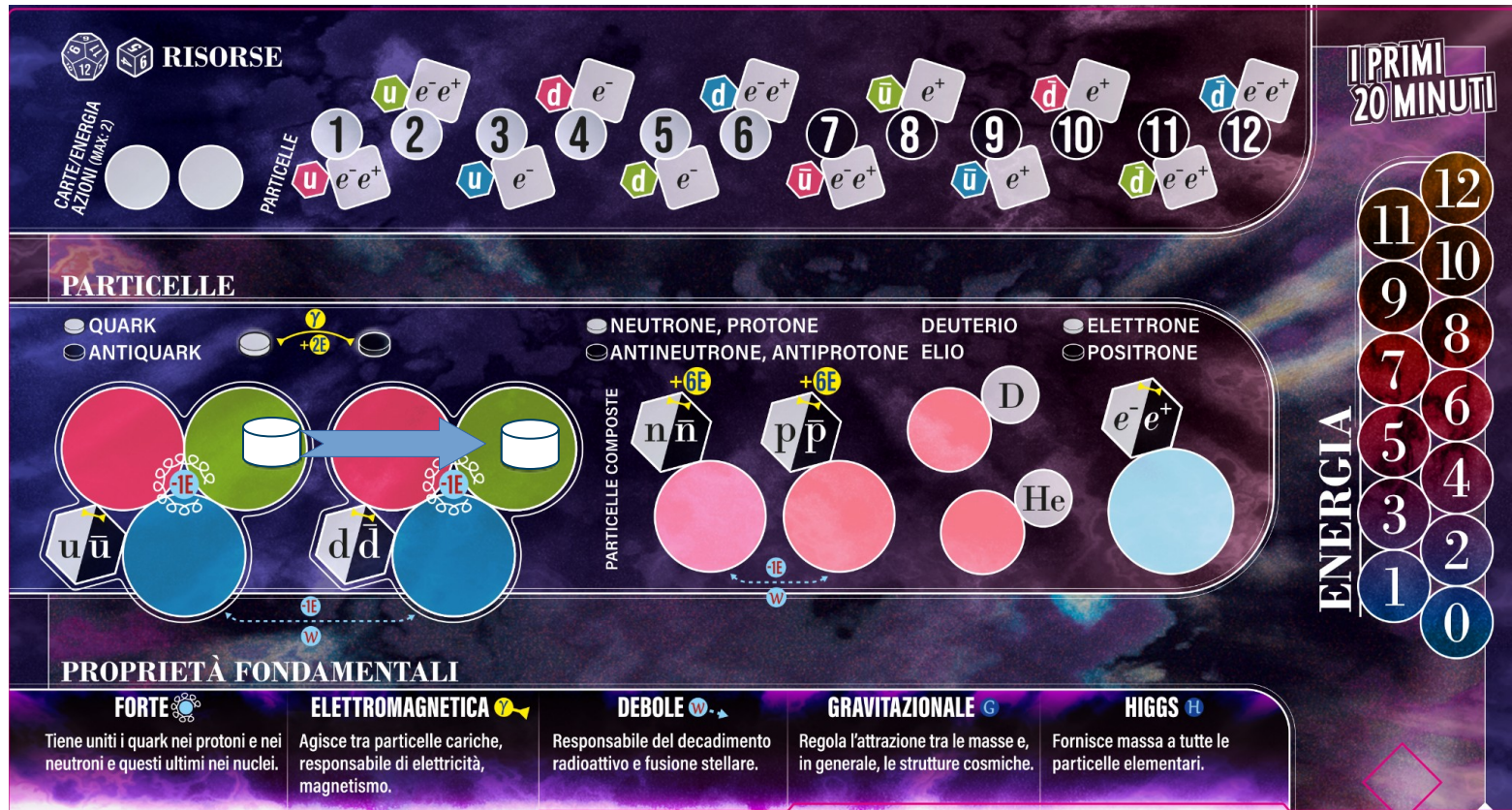
ENERGIA

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I PRIMI 20 MINUTI

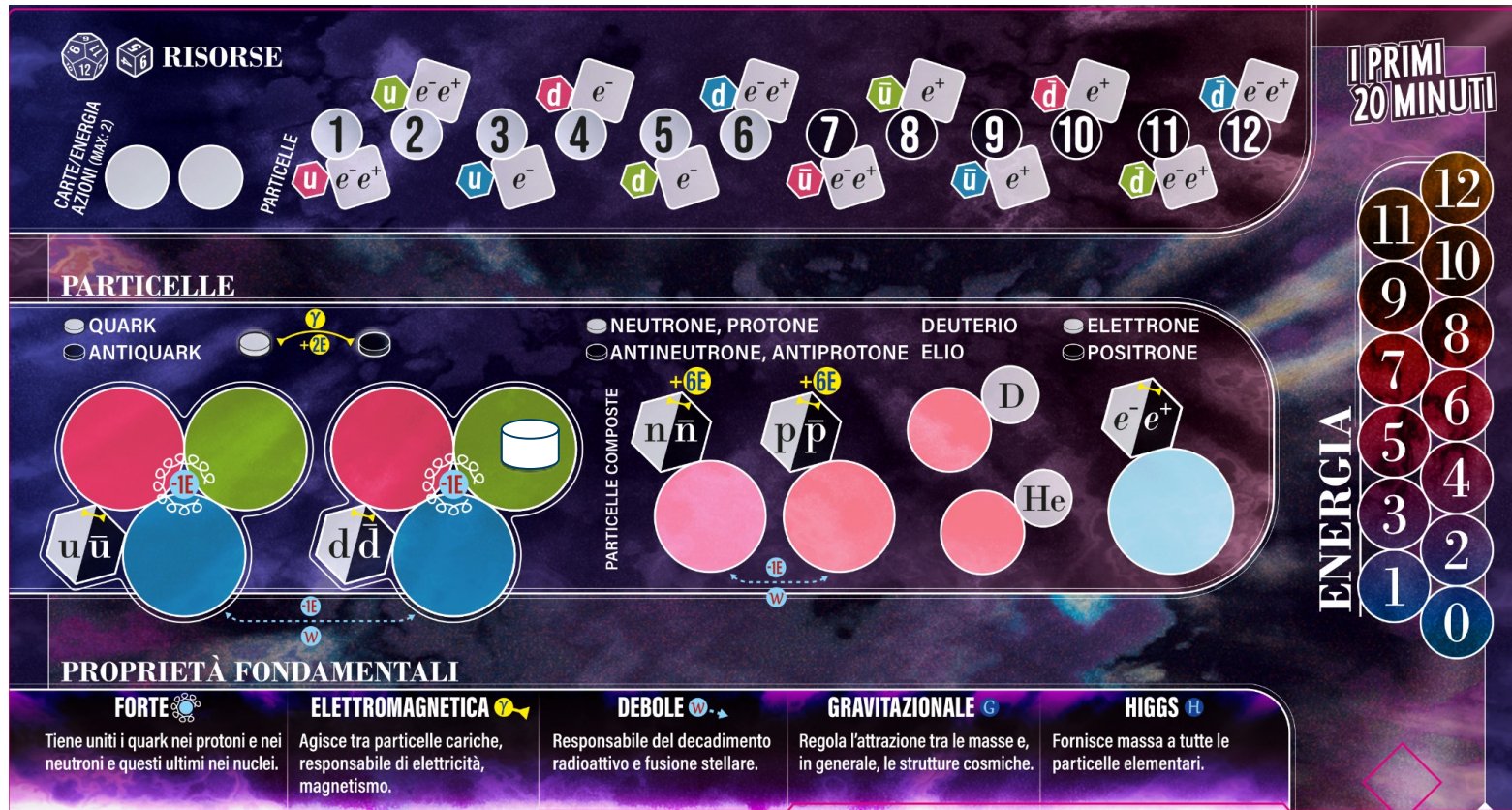
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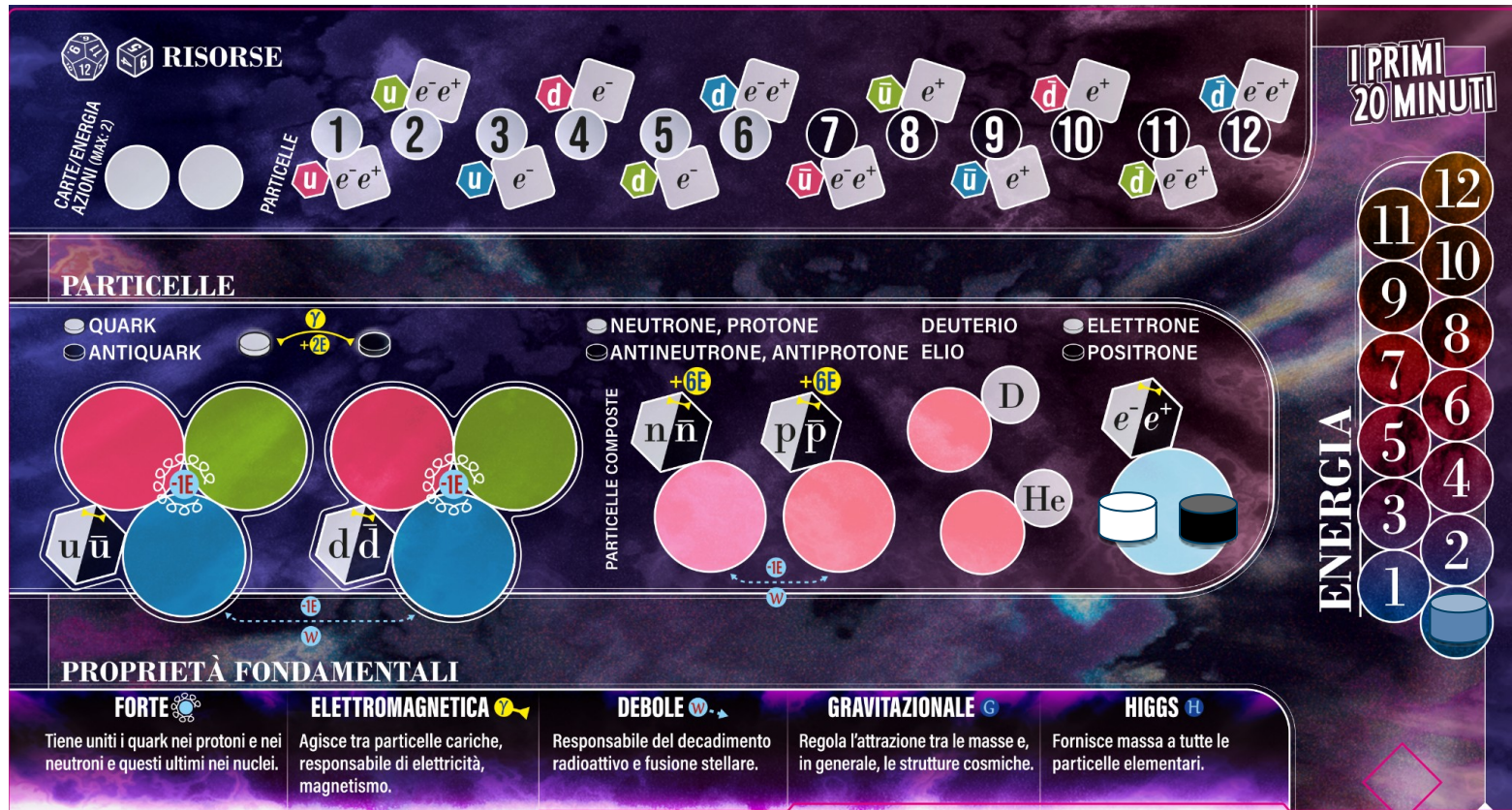
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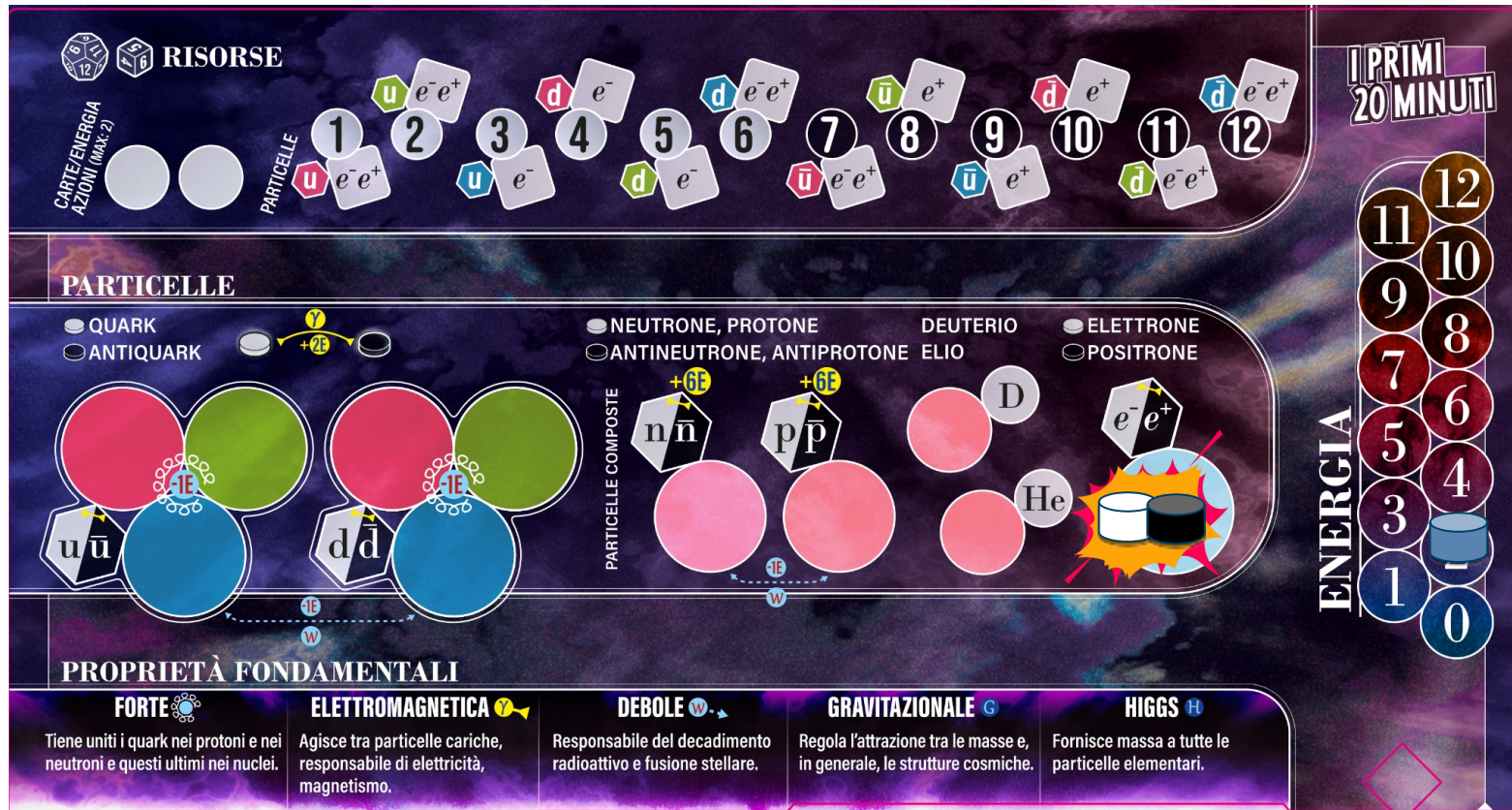
Matter and antimatter annihilates and produce energy

Electromagnetic Interactions



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Electromagnetic Interactions



First instants of the universe

~14 billions years ago: Big Bang Highest “temperature” and energy density. Same amount of matter and antimatter

Universe starts to cool down

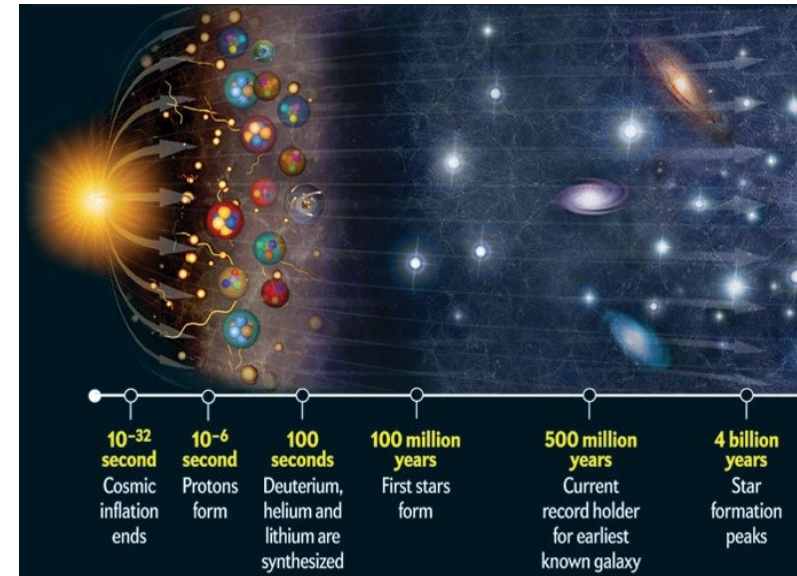
10^{-34} seconds after Big Bang, small unbalance of matter over antimatter. Every:

1000000000 antiparticles

There were

100000000**1** particle

All antiparticles annihilated with particles. All remaining particles built up our Universe

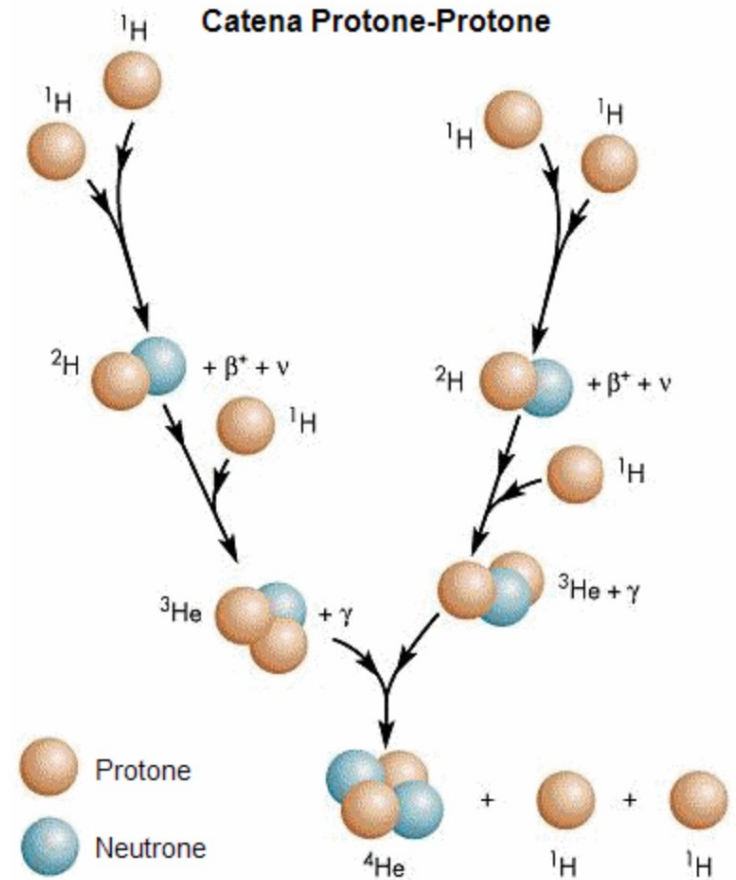


The remaining 20 Minutes

Free quarks start to bound together with strong interaction and built up protons and neutrons

Primordial Nucleosynthesis: After 20 minutes, from protons and neutrons Deuteron (D) and Helium (He) nuclei are created.

For atoms we had to wait a little bit more: 300k years



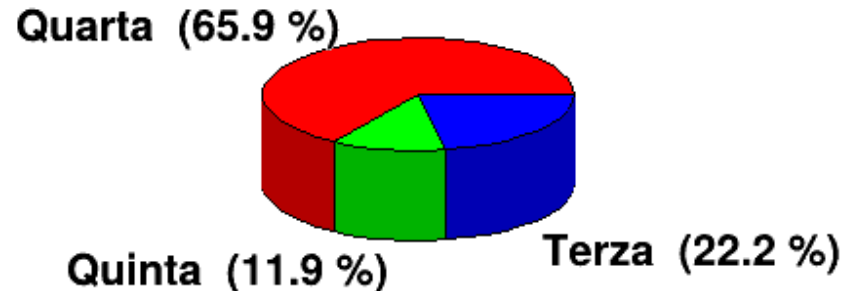
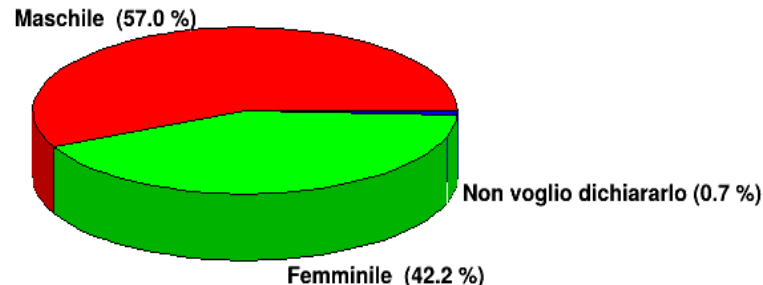


Evaluating the Impact

Feedback from players

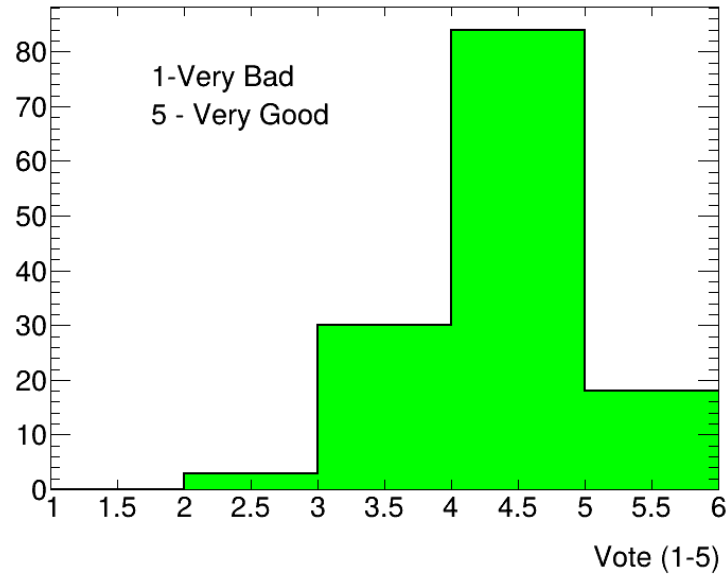
Short version game has been played extensively in the last couple of years

- Generic public: Scientific oriented festival (Science Festival, European Research Night), and scientific agnostic festivals g (Play, Lucca Comics IDEAG)
- Students: Optimal target are last three years of high school (Schools, Summer camps INFN). But has been played by 10-13 years old kids (Unijunior in Bologna) and also younger kids (first grade) → analysis of 135 answers of questionnaires collected during high school (mainly “Liceo Scientifico”) activities **(very preliminary analysis)**



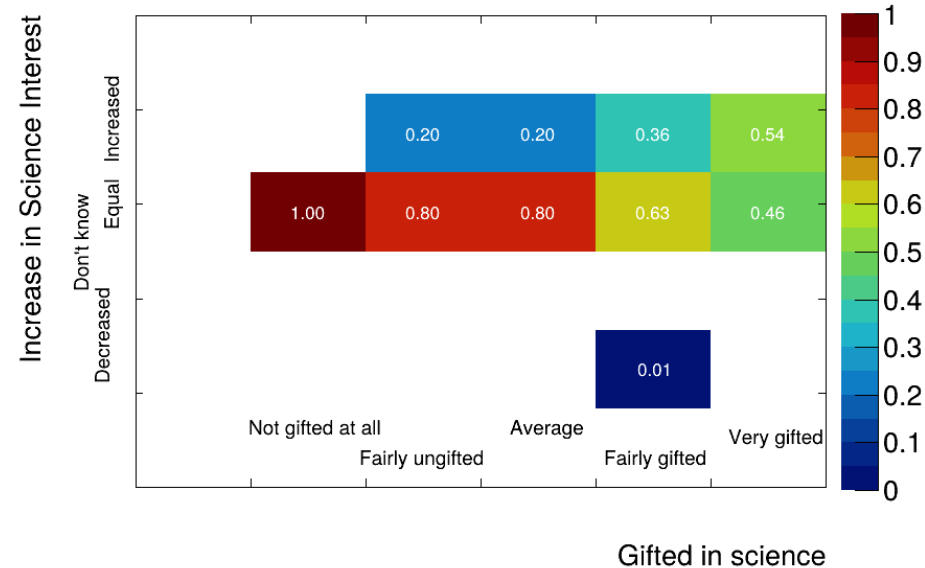
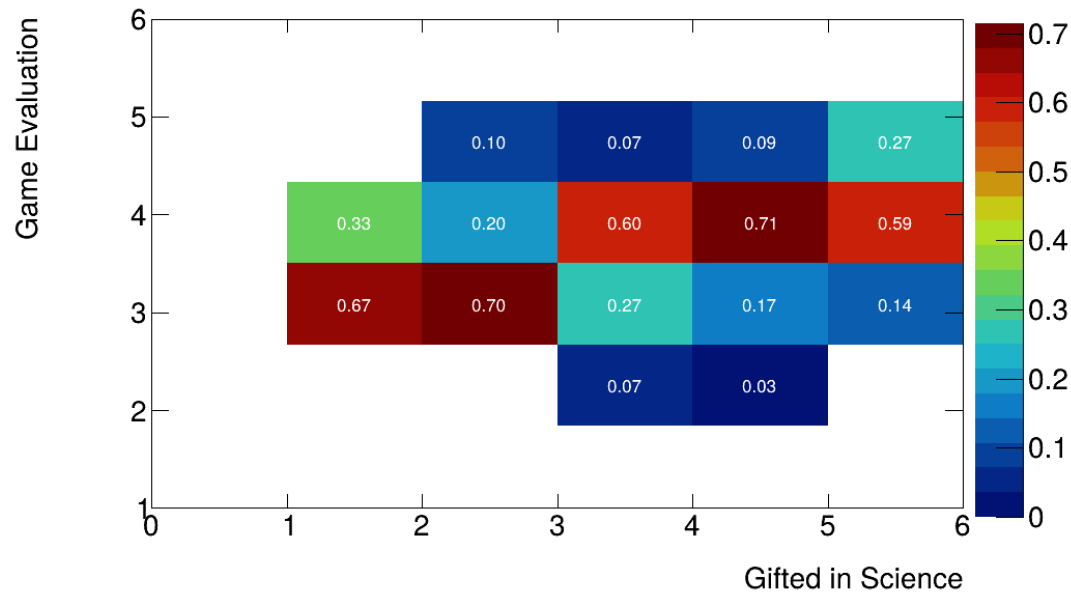
Feedback from high school students

Post answers to questionnaire



Feedback from high school students

Post answers to questionnaire



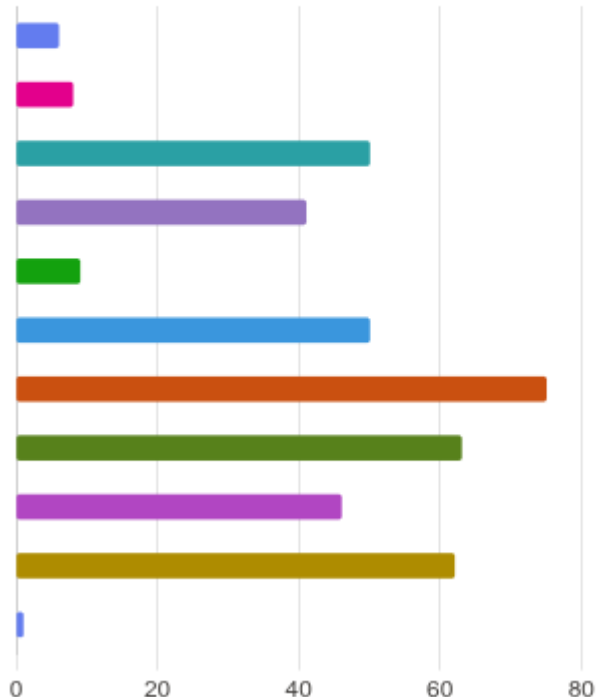
Feedback from high school students

Post answers to questionnaire
Main messages are kept.

21. Secondo te cosa vuole comunicare il gioco "I Primi 20 Minuti"?

[Più dettagli](#)

- Il lavoro dello scienziato è riconosciuto solo all'interno della comunità scientifica 6
- La ricerca in Fisica delle particelle in Italia è meno finanziata che in altri paesi 8
- La ricerca in Fisica delle particelle può rispondere a domande fondamentali... 50
- E' necessaria energia per costruire atomi più stabili 41
- Le pubblicazioni scientifiche sono molto utili per la ricerca in astrofisica 9
- Le evidenze scientifiche hanno mostrato una sparizione dell'antimateria nei primi 20... 50
- Gli atomi sono composti da protoni e neutroni, a loro volta composti da quark. 75
- L'atomo di Elio è un oggetto fondamentale per l'esistenza dell'Universo come lo... 63
- Esistono 4 interazioni fondamentali tra le particelle: Nucleare Forte, Nucleare Debole... 46
- Materia e Antimateria possono annichilirsi per produrre energia 62
- Altro 1

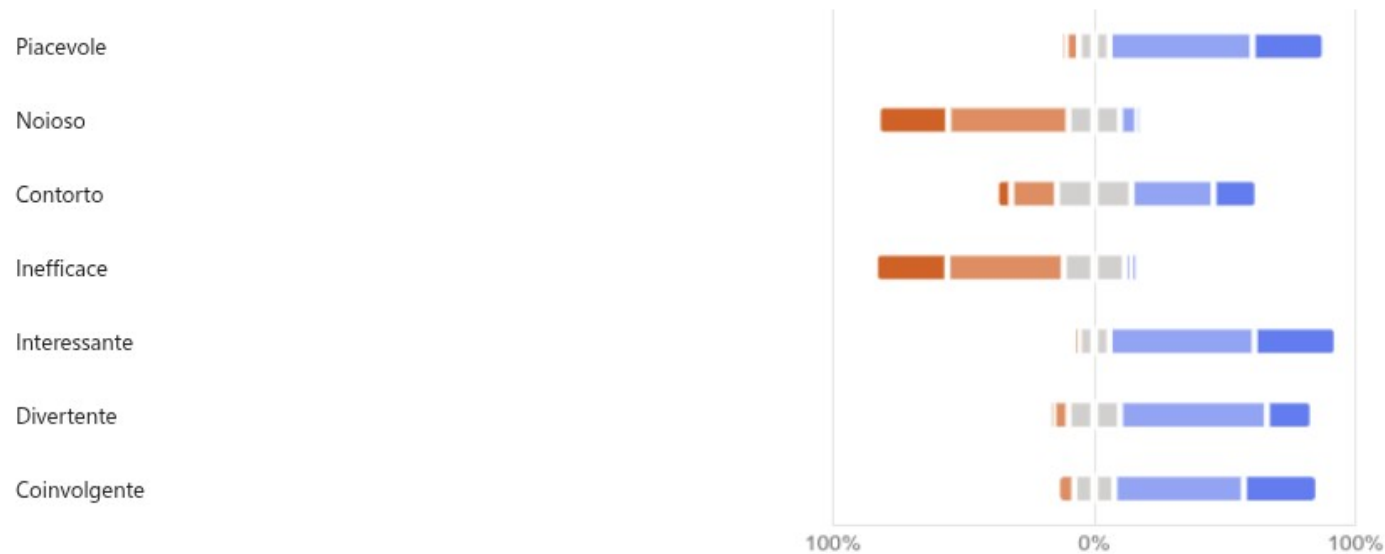


Post answers to questionnaire

19. Come descriveresti la tua esperienza con questo gioco ?

[Più](#)

● Per niente d'accordo ● Poco d'accordo ● Neutro ● Abbastanza d'accordo ● Molto d'accordo





Challenges

Impact with scientific/technical nomenclature

We are using names and mechanisms from the field. At first it could be intimidating (“I don’t know this stuff!”). Tutors should make clear that prior knowledge is not required. Things will become *more* clear while playing

Learning step-by-step

“Short” version has been implemented to contain all physics mechanisms. Leave the “Extended” version for successive games

Dynamics

Using same dice rolls reduces luck but could limit the strategic freedom (players tend to copy their decisions)



To take home

Science hasn't understood everything !

For example we stress the fact that the matter-anti matter asymmetry is not fully understood.. In the extended version there are card like: “Dark matter”, “Dark Energy”, “Wormhole”.... Science advances by steps: problems → theory predictions → experimental answers → new questions → and so on

Particle physics vs Cosmology (Interplay between physics of Small vs Large)

Physics of the fundamental interactions (particle physics) has shaped the Universe



Playability vs Scientific Accuracy

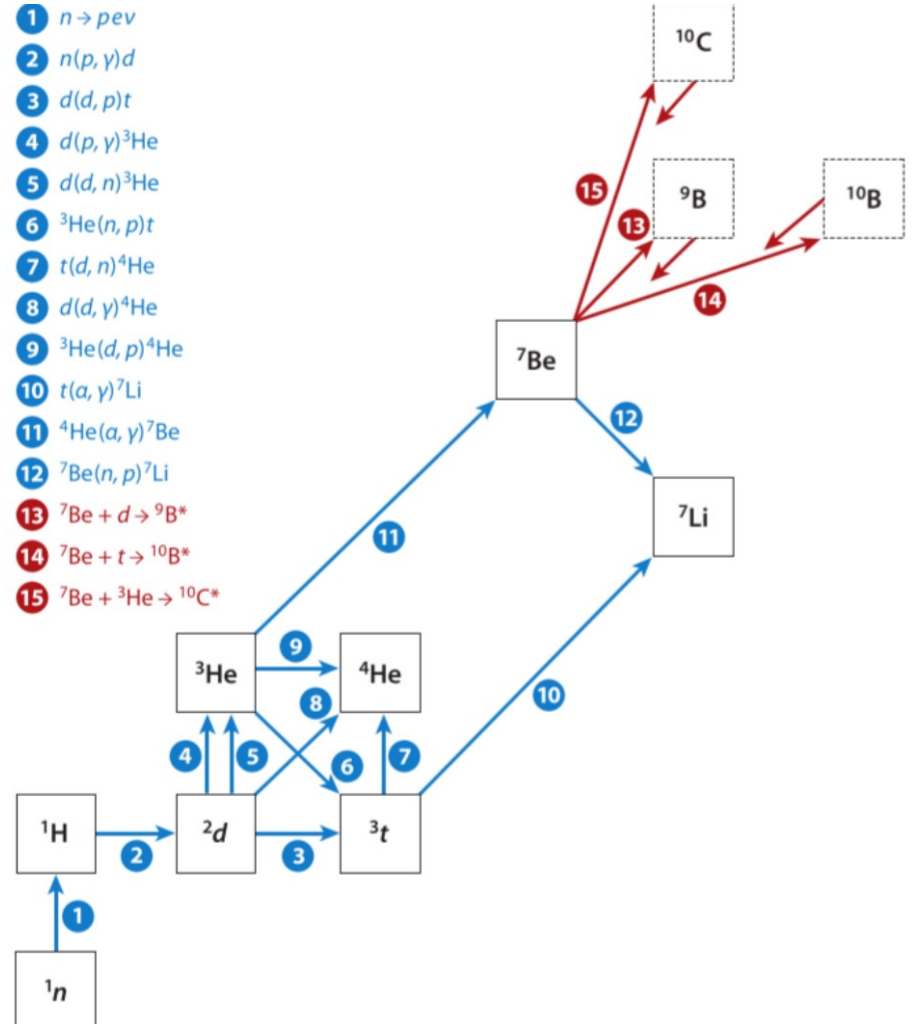
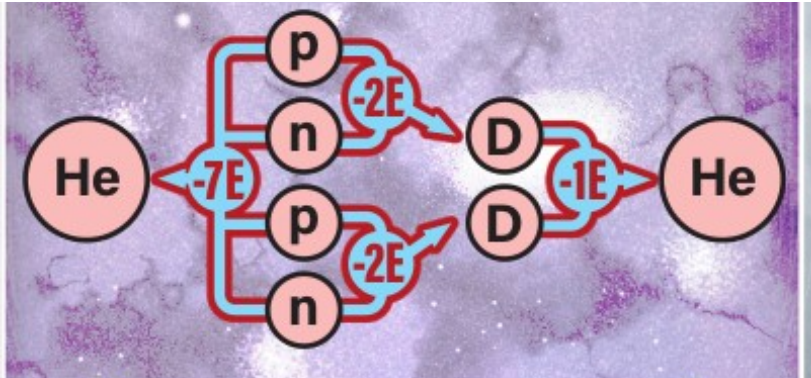


Spontaneous processes vs Endoenergetic processes

- Protons and neutrons building do not need of energy → Spontaneous process.
Same for matter-antimatter annihilation
- Deuteron and Helium nuclei formation are spontaneous processes too when the universe is cold enough → To make it happen before 20 minutes one needs energy to “slow down” particles.

Nucleosynthesis

Primordial nucleosynthesis is much more complicated than the one used in the game

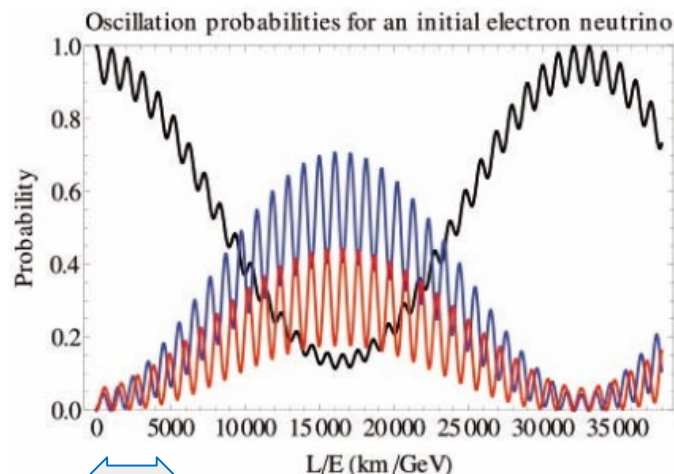




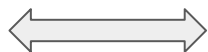
Back Up

Neutrino's Chess

Neutrinos oscillation → The experimental evidence that neutrinos have mass
→ Pure quantum mechanics effect



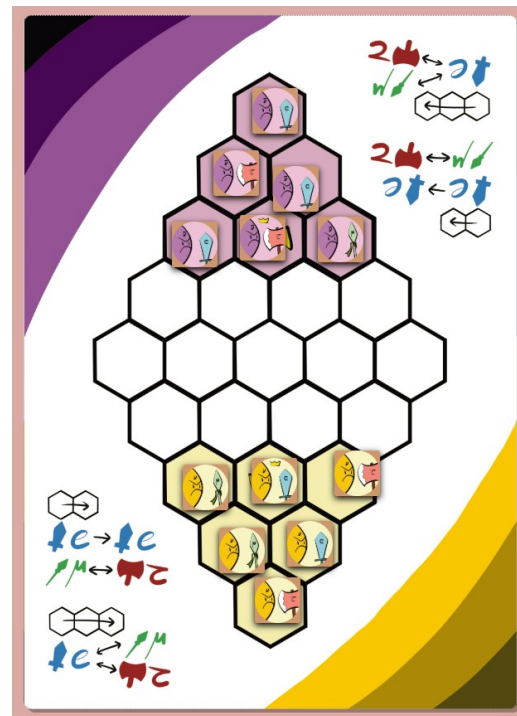
Small distances



Long distances

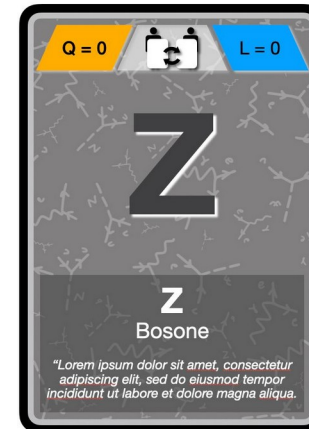
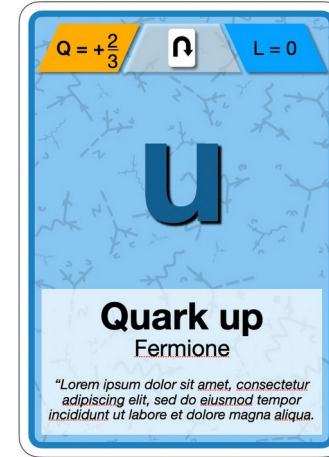
Game mechanics comes from physics process
for small distances electronic neutrinos do not change flavor
per for longest distances it has (almost) the same chance to transform in tau or muon neutrinos

Online platform developed by
Marco Tarini (UniMi)
[Link](#)



HEPCard

- Simple card game (targeting 10-13 years old but can be played by older)
- The message we want to transfer are:
 - There specific relations between particles in the Standard Model (conservation laws)
 - Fermions couple with bosons
- Abstract game
- Players have to organize the card in triplets (horizontal or vertical)



HEPCard: Rules

- 4x 3 card grid (covered)
- Un cover 3 cards
- In each turn the player can:
 - Draw a covered card from the face-down card deck
 - Uncover one of his/her card
 - Exchange the place two of his/her cards A
- The game ends when the first player uncovers all of his/her cards
- All the other players do the same (but cannot change the position of their cards)
- Count the points (each triplet counts 1)

