

# Quark Clash

a computer game based on particle physics

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**Nicolas Arnaud** ([narnaud@lal.in2p3.fr](mailto:narnaud@lal.in2p3.fr))

Laboratoire de l'Accélérateur Linéaire (CNRS/IN2P3 & Université Paris-Sud)

*On behalf of the design & development team*



LPT Orsay



LABORATOIRE  
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LINÉAIRE

le cnam  
enjmin

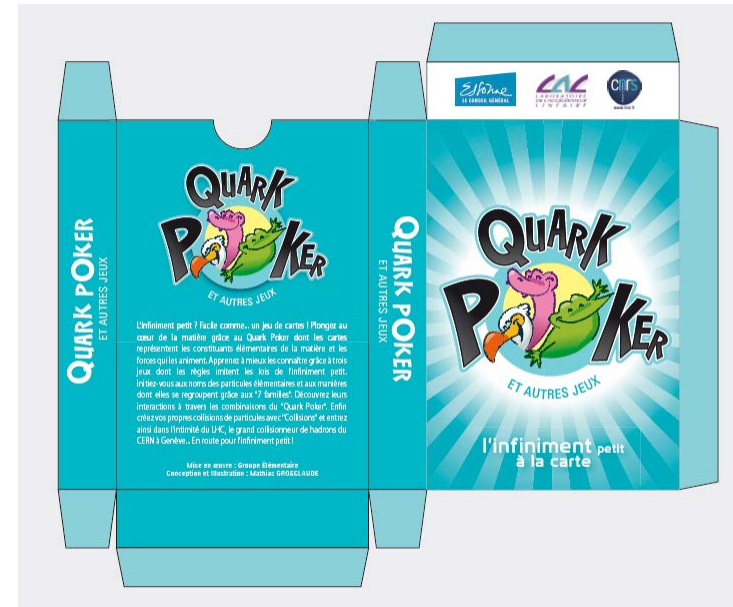


Physique des 2 Infinis et des Origines



# How this project started?

- **Quark poker** board game
  - [IPPOG DB](#)
  - (old) [Slides from CERN IPPOG meeting 2011](#)  
→ Teach elementary particle properties while having fun playing known card games
- **Semi-dormant project** in the past years due to lack of time to develop it more



- Feedback received: **paperboard cards** are « old-fashioned » in the digital area  
→ **Obvious continuation of the project: a computer game**
- **But how to proceed?**
  - No experience in computer game
  - No expert in our labs  
→ Graphic designer, computer professionals, engineers and physicists but no game designer/programmer, etc.

# Well, we got lucky...

- Fall 2014: contacted by a teacher of « ENJMIN » interested in the « **Passeport pour les deux infinis** » book

- [IPPOG DB](#)

→ What is « **ENJMIN** »?

- « **École Nationale du Jeu et des Médias Interactifs Numériques** »  
→ « **National School of game and interactive digital media** »

- [English website](#)

- Master degree diploma

- **First contacts by e-mail**

- Making the card game digital is a **good topic for a few month-long internship**

- **January 2015**: presentation of the project in the school premises

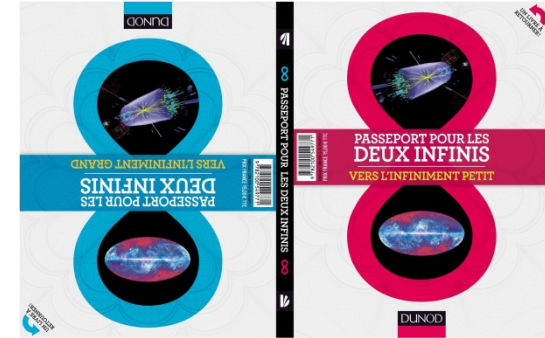
- Each team of students chooses a project they like

- **Spring 2015**: the internship is taking shape

- **2 months project (July & September) for a group of 4 students**

→ **Game design, programming, art & graphics, sound**

- Light (2.0!?) supervision: e-mail & videoconference only!



# Internship

- **At first a cultural clash!**
  - Generation gap
  - Research / Art worlds
  - Digital gaming part of the student DNA / we know it through our children (at best)
- **We had to know / understand each other first...**
- Students were « different » from those we usually have for « regular » internships
  - **They take over the internship topic and create something out of it**
- **Goal: to have a final (playable) product at the end of the internship**
  - Two months is a short period
    - **Focus on three particle interactions:**  
**an elementary particle is transformed into another one via a force carrier**
- Players have **cards symbolising particles and forces**
- Goal is to make **physically-valid interactions** using cards in hand and a common deck
- (Automated) **combat phase ending each turn** – to attract regular digital game players
  - **Cards have additional (non-physical) properties!**
- Lengthy discussions: not mandatory but gets player's attention

# The game: Quark Clash

- Three supported platforms: Windows, Mac and web
- In English
- Two play modes: single player (against the machine) or 2 players



# The game: Quark Clash



Style inspired by  
« The Particle Zoo »

NEW GAME

MORE ON  
PARTICLES

CREDITS

QUIT



# The game: Quark Clash



NEW GAME

MORE ON  
PARTICLES

CREDITS

QUIT

See last slide for details

# The game: Quark Clash

A 7-page document  
about particle physics



NEW GAME

MORE ON  
PARTICLES

CREDITS

QUIT

## More about particle physics

Quark Clash involves cards representing the elementary particles that are the basic components of matter, and you must combine them in groups of three following specific rules. Actually, this is not just a game: these combinations of three elementary particles correspond to the way that an elementary particle can be affected by the fundamental forces of Nature.

All the interactions between particles or their decays (for those which are not stable) can be viewed as the result of two such combinations. For example the muon has a lifetime of 2.2 microseconds. It decays into an electron, a muon-neutrino and an electron-antineutrino. This decay can be decomposed in two steps:

- First, the muon is transformed into a muon-neutrino under the action of a W-boson;



- Then, the W-boson decays into an electron and an electron-antineutrino.



Finding how such combinations of three elements are realized in Nature provides a key to understand how particles collide now in modern particle accelerators like the LHC near Geneva, similarly to what happened during a very short period after the Big Bang. At that time where a lot of energy was available in the Universe, there were elementary particles which have disappeared since long from our present environment. Using particle colliders, it is possible to recreate such objects and study their properties.



# The game: Quark Clash



NEW GAME

Ready for a game ?

MORE ON  
PARTICLES

CREDITS

QUIT

# New game menu



15 slides describing  
the game, the cards,  
the combinations,  
the rules and ...  
... the battles!

VS PLAYER

PLAY SOLO

TRAINING

TUTORIAL



CANCEL

# New game menu



VS PLAYER

PLAY SOLO

TRAINING

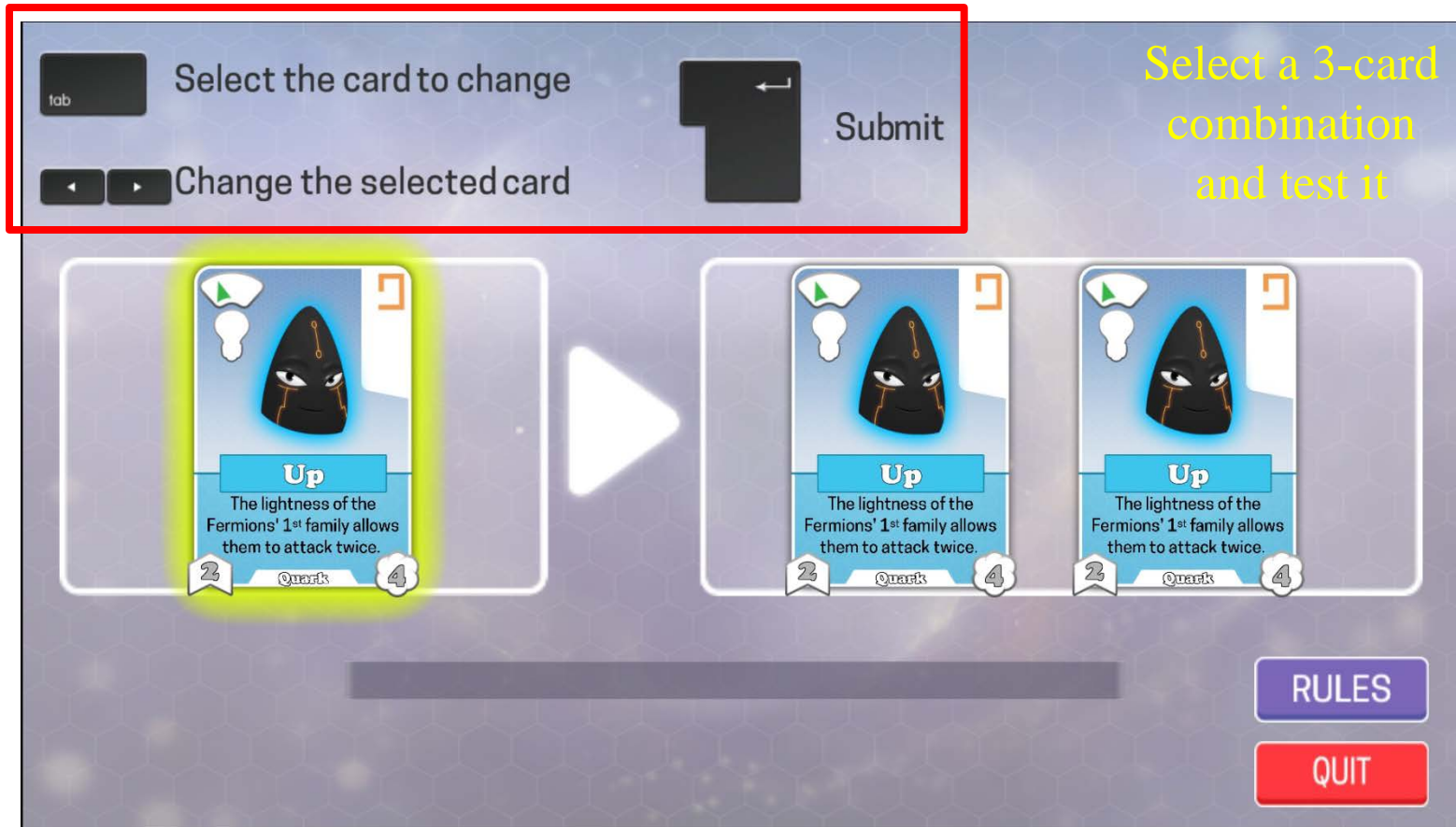
TUTORIAL

Training before playing

CANCEL

# Training

- Tool initially developed to test/debug the (in)valid combinations of cards
  - Found useful enough to be added to the game package





# Training

- Some examples

The screenshot shows a game interface with a hexagonal background. At the top, there are controls: a 'tab' button, a 'Select the card to change' instruction, a 'Submit' button with a left arrow, and 'Change the selected card' with left and right arrows. The main area features three cards in a sequence, connected by a right-pointing arrow. The first card is an 'Up' Quark with a green bar, a lightbulb icon, and a '2' icon. The second card is a 'Gluon' Boson with a blue bar, a lightbulb icon, and a '5' icon. The third card is an 'Up' Quark with a blue bar, a lightbulb icon, and a '4' icon. A red box highlights these three cards. At the bottom, there is a 'Transformation : STRONG' indicator, a 'RULES' button, and a 'QUIT' button.

Symbols  
and  
colors  
help



# Training

- Some examples

The screenshot shows a game interface with a hexagonal grid background. At the top left, there is a 'tab' button and the text 'Select the card to change'. Below this are two arrow buttons and the text 'Change the selected card'. To the right, there is a large black arrow pointing left and the text 'Submit'. In the center, three cards are displayed in a row, separated by a large white arrow pointing right. The first card is a **W<sup>-</sup> Boson** with a cost of 4 and a value of 2. Its description reads: 'The special relationship between the Z and W Bosons and the Higgs Boson blocks attacks they receive from it.' The second card is an **Electron** with a cost of 6 and a value of 2. Its description reads: 'The lightness of the Fermions' 1<sup>st</sup> family allows them to attack twice.' The third card is an **Electron Neutrino** with a cost of 4 and a value of 6. Its description reads: 'The lightness of the Fermions' 1<sup>st</sup> antfamily allows them to attack twice.' The Electron Neutrino card is highlighted with a yellow glow. At the bottom, there is a grey bar with the text 'Transformation : WEAK', a blue 'RULES' button, and a red 'QUIT' button.

# New game menu



VS PLAYER

PLAY SOLO

TRAINING

TUTORIAL

Time to play a game:  
either versus the computer,  
or with another player

CANCEL

# The « board » game

Computer



**Strange**

The versatility of the Fermions' 2d anti-family allows them to confer -1 / -1 to all opposing particles.

**3** Antiquark **3**

Member of the second anti-family, the anti-strange quark is the anti-particle of the strange quark. There is only a tiny fraction of anti-strange (and strange) quarks inside the proton because it is heavier than anti-up and anti-down quarks.  
 Lifetime :  $\sim 10^{-10}$  s  
 Mass : 0.1 GeV/c<sup>2</sup>  
 Spin : 1/2  
 Electric charge : +1/3  
 Weak charge : yes  
 Colour : 1 (anti-)colour

Nicolas






A boson is required

--	--	--	--	--	--

PLAY

PASS

RULES

QUIT



# The « board » game

**Computer**

**Strange**  
The versatility of the Fermions' 2d anti-family allows them to confer -1 / -1 to all opposing particles.

3 Antiquark 3

Member of the second anti-family, the anti-strange quark is the anti-particle of the strange quark. There is only a tiny fraction of anti-strange (and strange) quarks inside the proton because it is heavier than anti-up and anti-down quarks.  
Lifetime :  $\sim 10^{-10}$  s  
Mass : 0.1 GeV/c<sup>2</sup>  
Spin : 1/2  
Electric charge : +1/3  
Weak charge : yes  
Colour : 1 (anti-)colour

**Nicolas**

**Top**  
The mass of the Fermions' 2d family allows them to reduce the distance of opposing Particles by 1/1.

**Up**  
The lightness of the Fermions' 2d family allows them to reduce the distance of opposing Particles by 1/1.

**Top**  
The mass of the Fermions' 2d family allows them to reduce the distance of opposing Particles by 1/1.

**Strange**  
The versatility of the Fermions' 2d anti-family allows them to confer -1 / -1 to all opposing particles.

**Charm**  
The versatility of the Fermions' 2d family allows them to confer -1 / -1 to all opposing particles.

**Muon Neutrino**  
The versatility of the Fermions' 2d anti-family allows them to confer -1 / -1 to all opposing particles.

**Top**  
The mass of the Fermions' 2d family allows them to reduce the distance of opposing Particles by 1/1.

**Strange**  
The versatility of the Fermions' 2d family allows them to confer -1 / -1 to all opposing particles.

**Photon**  
Photon's luminous power gives -2 / -2 to charged opposing particles.

**Tau Neutrino**  
The mass of the Fermions' 2d family allows them to reduce the distance of opposing Particles by 1/1.

**Top**  
The versatility of the Fermions' 2d anti-family allows them to reduce the distance of opposing Particles by 1/1.

**W<sup>+</sup>**  
The special relationship between the 7 and W Bosons see the Higgs Boson. It is because they receive 1 unit.

A boson is required

**Charm**  
The versatility of the Fermions' 2d anti-family allows them to confer.

**Down**  
The lightness of the Fermions' 2d anti-family allows them to confer.

**Charm**  
The versatility of the Fermions' 2d anti-family allows them to confer.

**Muon**  
The versatility of the Fermions' 2d anti-family allows them to confer.

**Beauty**  
The mass of the Fermions' 2d anti-family allows them to confer.

**Strange**  
The versatility of the Fermions' 2d anti-family allows them to confer.

PLAY

PASS

RULES

QUIT

The two players with their « life bars »

# The « board » game

Computer's deck is hidden

**Computer**

**Common deck**

**PLAY**

**PASS**

**RULES**

**QUIT**

**Strange**  
The versatility of the Fermions' 2d anti-family allows them to confer -1 / -1 to all opposing particles.

**3 Antiquark 3**

Member of the second anti-family, the anti-strange quark is the anti-particle of the strange quark. There is only a tiny fraction of anti-strange (and strange) quarks inside the proton because it is heavier than anti-up and anti-down quarks.  
Lifetime :  $\sim 10^{-10}$  s  
Mass : 0.1 GeV/c<sup>2</sup>  
Spin : 1/2  
Electric charge : +1/3  
Weak charge : yes  
Colour : 1 (anti-)colour

**Nicolas**

**Charm**  
The versatility of the Fermions' 2d anti-family allows them to confer +1 / +1 to all opposing particles.

**Down**  
The lightness of the Fermions' 2d family allows them to confer -1 / -1 to all opposing particles.

**Charm**  
The versatility of the Fermions' 2d anti-family allows them to confer +1 / +1 to all opposing particles.

**Muon**  
The versatility of the Fermions' 2d anti-family allows them to confer -1 / -1 to all opposing particles.

**Beauty**  
The versatility of the Fermions' 2d anti-family allows them to confer +1 / +1 to all opposing particles.

**Strange**  
The versatility of the Fermions' 2d anti-family allows them to confer -1 / -1 to all opposing particles.

**Top**  
The versatility of the Fermions' 2d family allows them to confer +1 / +1 to all opposing particles.

**Up**  
The lightness of the Fermions' 2d family allows them to confer -1 / -1 to all opposing particles.

**Top**  
The mass of the Fermions' 2d anti-family allows them to confer +1 / +1 to all opposing particles.

**Strange**  
The versatility of the Fermions' 2d anti-family allows them to confer -1 / -1 to all opposing particles.

**Charm**  
The versatility of the Fermions' 2d anti-family allows them to confer +1 / +1 to all opposing particles.

**Muon Neutrino**  
The versatility of the Fermions' 2d anti-family allows them to confer -1 / -1 to all opposing particles.

**Photon**  
Photon's luminous power gives -2 / -2 to charged opposing particles.

**Top Neutrino**  
The mass of the Fermions' 2d anti-family allows them to confer +1 / +1 to all opposing particles.

**Top**  
The versatility of the Fermions' 2d family allows them to confer +1 / +1 to all opposing particles.

**W<sup>+</sup>**  
The special relationship between the 7 and W Bosons see the Higgs Boson. It is the only one that can be created from a quark and an anti-quark.

**A boson is required**

Your deck



# The « board » game

**Computer**

**Strange**  
The versatility of the Fermions' 2d antifamily allows them to confer -1 / -1 to all opposing particles.

**3** Antiquark **3**

Member of the second anti-family, the anti-strange quark is the anti-particle of the strange quark. There is only a tiny fraction of anti-strange (and strange) quarks inside the proton and anti-down quarks.  
Lifetime :  $\sim 10^{-10}$  s  
Mass :  $0.1 \text{ GeV}/c^2$   
Spin :  $1/2$   
Electric charge :  $+1/3$   
Weak charge : yes  
Colour : 1 (anti-)colour

**Nicolas**

**Computer**

**PLAY**

**PASS**

**RULES**

**QUIT**

When the mouse pointer passes over a card, information appears on the left hand side

# Card contents

- Slide taken from the tutorial

## I - Cards

- Each card has 8 to 10 data :

Family symbol\*

Electric charge

Symbol(s) of Electro-weak interaction\*\*

Particle character

Color(s) of Strong interaction

Particle name

Card Ability

Defense points

Attack points

Particle type

**Charm**

The versatility of the Fermions' 2d Family allows them to confer -1 / -1 to all opposing particles.

3

Quark

3

3

\* : Only for Quarks and AntiQuarks    \*\* : Except Gluons



# Let's play!

- Strange quark radiating a photon



**Photon**  
Photon's luminous power gives -2 / -2 to charged opposing particles.

**Boson**

Proposed by A. Einstein in 1905, it transmits the electromagnetic interaction. It is the only stable particle with zero mass and, for this reason, it is the fastest particle in Nature, travelling at the speed ... of light. It is identical to its antiparticle. The photon interacts only with particles having an electric charge; as a result, it does not interact with other photons.

Lifetime : Stable  
Mass : 0 GeV/c<sup>2</sup>  
Spin : 1  
Electric charge : 0  
Weak charge : no  
Colour : no


Computer

PLAY

PASS

RULES

QUIT



**Strange**

▶



**Photon**



**Strange**

Transformation : ELEC

Nicolas

# Let's play!

- Quark flavour changing transformation

Result of past fights

**W<sup>+</sup>**

The special relationship between the Z and W Bosons and the Higgs Boson blocks attacks they receive from it.

4 **Boson** 2

With the W<sup>-</sup> and the Z<sup>0</sup> bosons, the W<sup>+</sup> boson transmits the weak interaction (the symbol "W" is derived from the word "weak"). Postulated in the 1970ies, it was discovered at CERN (Geneva) in 1983. The W bosons are the only particles that can interact with two particles from different families. The W<sup>+</sup> generates β<sup>+</sup> radioactive beta decays. The W<sup>-</sup> is the antiparticle of the W<sup>+</sup>.  
 Lifetime: ~ 3 x 10<sup>-25</sup> s  
 Mass: 80.385 GeV/c<sup>2</sup>  
 Spin: 1  
 Electric charge: +1  
 Weak charge: yes  
 Colour: no

**Nicolas**

**Computer**

Computer's hand:

- Electron Neutrino
- Photon
- W<sup>+</sup>
- Muon
- Electron Neutrino

Transformation: WEAK

Nicolas's hand:

- Charm
- Electron Neutrino
- Charm
- Down
- Up

PLAY

PASS

RULES

QUIT

# 'Live' combat

**Nicolas**

**PLAY**

**PASS**

**RULES**

**QUIT**

**Transformation : WEAK**

**Top**  
The mass of the Fermions' 2<sup>o</sup> family allows them to reduce the balance of opposing Particles by 1.

**Charm**  
The versatility of the Fermions' 2<sup>o</sup> family allows them to control 1/2 of all opposing particles.

**Beauty**  
The mass of the Fermions' 2<sup>o</sup> family allows them to reduce the balance of opposing Particles by 1.

**Charm**  
The versatility of the Fermions' 2<sup>o</sup> family allows them to control 1/2 of all opposing particles.

**W**  
The special relationship between the 2<sup>o</sup> and W Bosons are the biggest Bosons blocks attacks they receive.

**Top**  
The mass of the Fermions' 2<sup>o</sup> family allows them to reduce the balance of opposing Particles by 1.

**Meson Neutrinos**  
The versatility of the Fermions' 2<sup>o</sup> family allows them to control 1/2 of all opposing particles.

**Meson Neutrinos**  
The versatility of the Fermions' 2<sup>o</sup> family allows them to control 1/2 of all opposing particles.

**Tail**  
The mass of the Fermions' 2<sup>o</sup> family allows them to reduce the balance of opposing Particles by 1.

**Up**  
The lightness of the Fermions' 1<sup>o</sup> family allows them to attack twice.

**Down**  
The lightness of the Fermions' 1<sup>o</sup> family allows them to attack twice.

**Down**  
The lightness of the Fermions' 1<sup>o</sup> family allows them to attack twice.

**Beauty**  
The mass of the Fermions' 2<sup>o</sup> family allows them to reduce the balance of opposing Particles by 1.

**Charm**  
The versatility of the Fermions' 2<sup>o</sup> family allows them to control 1/2 of all opposing particles.

**Meson Neutrinos**  
The lightness of the Fermions' 1<sup>o</sup> family allows them to attack twice.

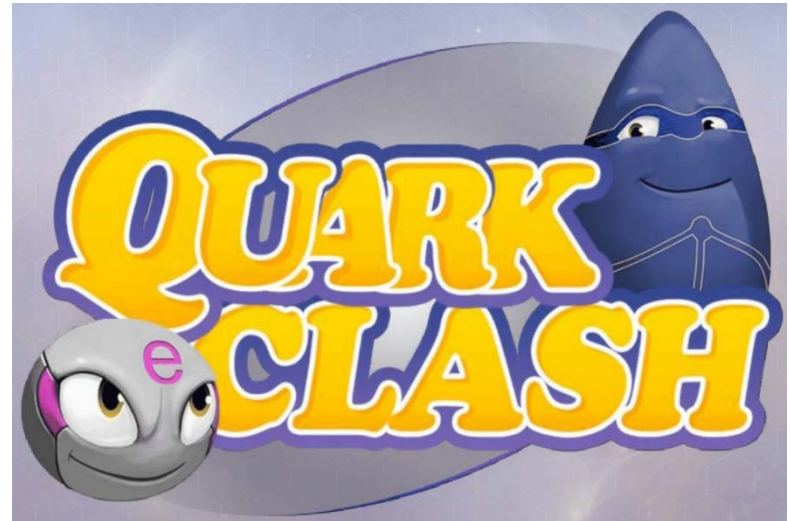
**Up**  
The lightness of the Fermions' 1<sup>o</sup> family allows them to attack twice.

**Top**  
The mass of the Fermions' 2<sup>o</sup> family allows them to reduce the balance of opposing Particles by 1.



# Next steps

- **Add the game to the IPPOG database**
  - Last version (with a few bug fixes) available early this week  
→ Tests are underway
- **Get feedback from you and other players**
- **Debriefing meeting at LAL Orsay next week**
  - How to use the Quark Clash game?
  - Do we want to have a similar internship next Summer?
  - If yes, what should be modified/improved?  
→ Scope, organization, support
- **To contact us:**  
[elementaire@lal.in2p3.fr](mailto:elementaire@lal.in2p3.fr)



# Credits

## **Lead Game Design**

Mathilda Kallouch Neuville  
mathilda.kallouch@gmail.com

## **Game Design**

Patrick Roudeau, Laboratoire de l'Accélérateur Linéaire (LAL)  
Sébastien Descotes-Genon, Laboratoire de Physique Théorique d'Orsay (LPT)

## **Programming**

Judicaël Abecassis  
judicael.abecassis@gmail.com

## **Art**

Leila Chihab  
leila.chihab@gmail.com

## **Sound**

Gaspard Morel  
gaspardmorel@mac.com

## **CONTRIBUTORS**

Sebastien Descotes-Genon  
Michel Jouvin  
Patrick Roudeau  
Nicolas Arnaud  
Antoine Perus  
Cynthia Vallerand  
Guillaume Levieux



# Battles

- Each card has three properties: attack, defense and a special ability
    - Common to many recent card games, digital or not (Pokemon, Magic)
      - Concepts familiar to (experienced) players – unlike particle physics
  - The longer the particle lifetime the more defense points it owns
  - Heavier particles have more attack points
  - Particle and antiparticles have the same properties
- The most experimental part of the current game