Report:
Solving superconformal field theories by bootstrap methods

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MidTerm Review of the Fellini programme

- *Quantum Field Theory* (QFT) is a universal framework for theoretical physics that successfully describes a variety of physical systems.
- *Challenge*: understand QFTs in the strongly coupled regime.
- *Dream*: develop tools that use only symmetries, self-consistency and a small number of extra physical inputs.

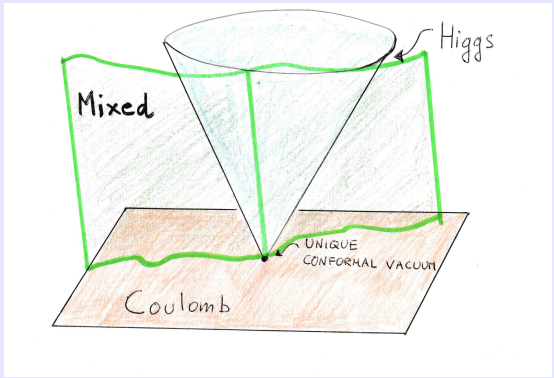
- *Conformal Field Theories* (CFTs) are an extremely important class of QFTs (from boiling water to quantum gravity).
- *Mathematically* well defined.
- *Conformal Bootstrap*: a dream come true.
- Add *Supersymmetry*: additional tools and rich mathematical structures.

Type of questions

A. Look at theory space, classify/organize super-CFTs (SCFTs).

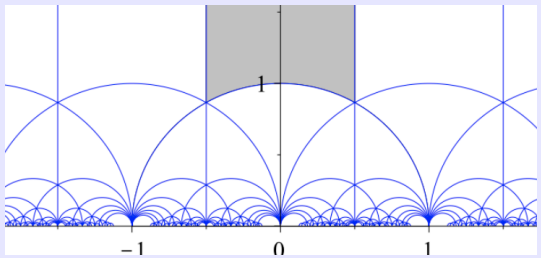
B. Study specific SCFTs.

In my Fellini project I will address these type of questions, mostly:



$\Rightarrow$ Vertex Operator Algebra
(associated to $\mathcal{N}=2$ SCFTs in 4d)

The Queen of gauge theories is $\mathcal{N}=4$ *super Yang-Mills (SYM)*.
Labelled by a complex number τ and a choice from $\mathfrak{a}_r, \mathfrak{b}_r, \mathfrak{c}_r, \mathfrak{d}_r, \mathfrak{e}_{6,7,8}, \mathfrak{f}_4, \mathfrak{g}_2$, $r=1,2,\ldots$



- It is an exciting time to bootstrap SCFTs! Innovation
- Impact on several communities of physicists and mathematicians.

Academic impact

The strategy that I will use to increase the likelihood of achieving a strong academic impact includes:

- *Scientific articles*.
- *Conferences and Meetings*: I will present my work at conferences and seminars.
- *Research visits and Collaborations*: I have strong collaborative links with researchers in the University of Oxford, in continental Europe (Hamburg University) and in the US (Stony Brook University).
  Interaction and collaborations with the member of the host department (Parma) and Milano Bicocca will be crucial to develop my programme.
- *Workshops organisation*: I plan to organise a small yearly workshop bringing together physicist and mathematicians working on problems connected to my research programme.
- *Lectures*: I plan to deliver a series of lectures on my project to graduate students. This will enhance the impact of my research and make it accessible to the next generation of scientists.

The Fellini fundings will be essential to carry out these activities.

- *Research Skills and techniques*: I plan to receive some training in specific new areas which are tangential to my Fellini project. This will be implemented by inviting external scientists to my location to give lectures and participating to existing workshops.
- *Management of Research funds*: essential to reach independence.
- *Other professional training*:
  - I plan to organise an informal Journal Club in the University of Parma. This will be important to train new generation of scientists and will also help me improve my teaching and communication skills.
  - I plan to supervise or co-supervise students.
- *Research management*: I plan to apply for an ERC consolidator grant in early 2022. This is a very competitive grant and I hope that the research produced during the Fellini fellowship will make me a strong candidate for this post.

- *Public engagement*: I will implement a public engagement plan developed in two directions:
  - visiting local schools,
  - engage with general public audiences (like "a pint of science").

  The course"A First Training On Public Engagement - On Line" (September 2020) organised by the INFN has been very helpful concerning these aspects.
- *Secondment*: needs of the project.

I am also looking forward to interactions with the other Fellini fellows!

Thanks!