

Colors: collaborators in blue, research topics in green.

## Notes from CV Bert Schellekens

Bert was born in Nijmegen, on 4 march 1954.

### University

In 1972 he started studying Physics at the Radboud Universiteit, where soon he realized that he was especially attracted to Particle Physics.

### PhD

From 1977 to 1981 he did his PhD thesis, also in the Radboud Universiteit, with title "[Perturbative QCD](#) and lepton production" working under the official supervision of Roger Van Royen. In practice, his supervisor was [Willy van Neerven](#), with whom he published two articles, and he also showed much independence publishing two articles by himself.

### First postdoc

From 1981 to 1983 Bert was a postdoc at FermiLab, where he showed a special talent to interact and collaborate with other physicists. With [Andrzej Buras](#) and [Sally Dawson](#) he worked on [composite and technicolor models](#); also with Sally Dawson he investigated [monopole catalysis of proton decay](#); with [Cosmas Zachos](#) he worked on [masses of GUT monopoles](#), and with [In-Gyu Koh](#) and [Kyungsik Kang](#) he studied [mathematical aspects of the preon model](#).

### Second postdoc

From 1983 to 1985 he was a postdoc at Stony Brook University, where he started working on [Kaluza-Klein theories](#), partly with [Krzysztof Pilch](#). In 1985, after the first heterotic string papers by Gross et al, and the Calabi-Yau compactification paper by Candelas et al, Bert and Krzysztof decided to work on [string theory](#),

unknowingly that this was going to determine the direction of the rest of their careers. Looking back at it now, this was clearly the best decision they could have made, as it brought a lot of exciting research opportunities for decades to come.

## CERN

In 1985 Bert started working at CERN, initially as a fellow, and after 1987 as a staff member. His first paper was with [Hermann Nicolai](#), and later they were joined by [Francois Englert](#). The goal of the work was to explore [relations between all known string theories](#) via the bosonic one, and it led to an insight that became important later that year. A few months later in the same year 1986 he started working with [Nick Warner](#) on various projects. The most exciting one concerned the relation between [anomaly cancellation and modular invariance in string theory](#). To understand this they constructed a mathematical object that they called the "*Character Valued Partition Function*", but soon they learned, via Ed Witten, that the same object had been constructed simultaneously by mathematicians, who gave it the much sexier name "*Elliptic Genus*". This is the name generally used since then and it is still regularly used in physics and mathematics papers.

At the end of 1986 Bert wrote a paper on [chiral four-dimensional heterotic strings](#), with [Wolfgang Lerche](#) and [Dieter Lüst](#). It became his most cited paper and in it *they strongly argued against the prevailing Princeton point of view that string theory would have a unique "vacuum" corresponding to the Standard Model*. In May 1987 he came to the conclusion that *this was not just a bug, but an essential feature*. This was a pivotal moment in his career, and he never looked at the Standard Model in the same way after that.

However, that view was very controversial because it was bringing *anthropic reasoning* into the discussion. For this reason, Bert only gathered enough courage to discuss it publicly in 1998, although only in Dutch, when it became the subject of his inaugural speech as Professor in Nijmegen. It still took another five years until that line of thought became a topic of discussion in string theory, after Lenny Susskind's paper "[The Anthropic Landscape of String Theory](#)". This paper was much more concrete than anything Bert had said. It brought the cosmological constant into the discussion, and argued for the existence of a huge ensemble of

long-lived de Sitter vacua in string theory. The concept as well as the existence of this landscape still remains controversial today.

During the years 1987 and 1988 Bert worked on various aspects of his papers from 1986, with [Pilch](#), [Warner](#), [Lerche](#), and [Bengt Nilsson](#). In 1989 he started working with [Shimon Yankielowicz](#) on [modular invariant partition functions](#). Using the "Verlinde formula" they developed a tool they called "*simple currents*" to build partition functions. Also with Shimon he did the ground work of a formalism to resolve simple current fusion fixed points in these constructions. Furthermore they studied simple current heterotic spectra using "Gepner models".

In 1990 Bert met [Beatriz Gato Rivera](#), his wife since August 1991, and by now his most frequent collaborator. With her he started a programme towards the [full classification of all simple current partition functions](#), later completed in collaboration with [Max Kreuzer](#).

In 1992 Bert computed a -- presumably complete -- [list of the meromorphic conformal field theories with central charge 24](#). The concept of meromorphic CFT's as well as the issue of their classification had been introduced by Peter Goddard one year earlier. Using the tools developed in the preceding years (in particular the elliptic genus and simple currents) and a large amount of computer calculus he was able to address this problem. *The paper steadily gained attention during the past thirty years, mainly in the mathematical field of Vertex operator algebras*. This work was mainly done at Nikhef, although he was still employed by CERN. Nikhef had promised him a permanent position after his CERN staff position, and as part of that agreement he visited Nikhef one month each year.

## NIKHEF

In October 1992 Bert started working at Nikhef. The first years were dominated by collaborations with [Jürgen Fuchs](#) and [Christoph Schweigert](#), respectively a Heisenberg fellow and a PhD student, at Nikhef. They worked on [Galois symmetry in CFT](#) (also with Beatriz), and completed the [fixed point resolution program](#) he started in 1989 with Shimon Yankielowicz. This led to more novel mathematical

features, which they called "orbit Lie algebras" and "twining characters". It was yet another time when Bert's work found a place in mathematics.

During a visit to Tel Aviv University in 1993 Bert wrote a paper with Ofer Aharony and Shimon Yankielowicz on charge sum rules of  $N=2$  superconformal field theories. In 1997 he wrote a paper with Eliezer Rabinovici of Hebrew University, Jerusalem on  $(2,1)$  heterotic string classification and he was also involved in the organisation of the 1997 string conference in Amsterdam. With Jos Vermaseren and his student Timo van Ritbergen he wrote a paper in 1998 on group theory factors for Feynman diagrams, combining the elliptic genus and Jos's impressive FORM programme. This paper became his second most-cited one.

In 1997, Bert was appointed as Extraordinary Professor at the Radboud Univ. in Nijmegen, and he kept this position for 20 years, teaching once per week during four months, every year. His inaugural speech "Naar een waardig slot", can be considered the first "serious" attempt to give shape to the string landscape ideas, although he only translated this speech to English in 2006.

Towards the end of the millennium Bert's interest moved to boundary CFT and non-orientable CFT. He worked on that subject with his students Lennaert Huiszoon and Nuno Sousa, while Fuchs and Schweigert, who had left Nikhef, worked on boundary CFT. They all combined their efforts in 2000, together with Johannes Walcher, in a paper that incorporated all their previous work in one simple, elegant formula, which they jokingly called the "*Formula of Everything*". This formula was the basis for later work on open string model building.

Bert's interest in open strings was stimulated to a large extent by Augusto Sagnotti, then at Tor Vergata University in Rome. He was a pioneer of open string theory, and saw very clearly that the previous work Bert did with Yankielowicz, and especially with Fuchs and Schweigert, should have very rich applications to boundary and non-orientable CFT's. Augusto invited Bert and Beatriz to Rome in 2001 and energetically shared his expertise. During that time Bert also wrote a paper with Yassen Stanev from Tor Vergata.

Bert hesitated a few years to jump into open string model building (intersecting brane model building), because that field seemed overcrowded. In the mean time he wrote papers on [orientifolds](#) with [Huiszoon](#), the Nikhef postdocs [Koenraad Schalm](#) and [Fabio Riccioni](#), and with [Beatriz](#) and his student [Tim Dijkstra](#).

In 2004 Bert decided (with [Huiszoon](#) and [Dijkstra](#)) that they did have potentially something new and interesting [to contribute to the field of open string model building](#). After extensive computer searches, and using the formalism he had developed in the years 1992-2000 applied to the so-called "Gepner models", *they succeeded in producing a large database of open string theories with the low-energy spectrum of the supersymmetric standard model*. This paper is Bert's third most-cited one.

This line opened the way for a lot of other work during the next decade, until 2014. With [Beatriz](#), Bert worked on [global anomalies and non-supersymmetric open string spectra](#). With [Elias Kiritsis](#) and [Pascal Anastasopoulos](#) he examined [more general hypercharge choices](#) that yield the standard model. With [Kiritsis](#) and [Michael Lennek](#) he studied [free fermion orientifolds](#) and specific problems of [open-string based SU\(5\) GUT models](#). And he continued work along these lines with [Anastasopoulos](#), [George Leontaris](#) and [Robert Richter](#). With [Kiritsis](#) and [Tsulaia](#) he studied [fermions mass hierarchies](#). With [Luis Ibañez](#) and [Angel Uranga](#) he worked on [instanton induced neutrino masses](#), as well as [discrete symmetries and axions](#). With his student [Michele Maio](#) he studied [permutation orbifolds](#) and their boundary CFT's.

Returning to closed strings, from 2009 until 2011 Bert and [Beatriz](#) explored various [new classes of heterotic Gepner models](#), building on work with Shimon Yankielowicz in 1990.

In 2006 Bert finally put his thoughts in writing regarding [the landscape](#) idea, by translating his inaugural speech in Nijmegen Radboud University from 1998 to English, as mentioned before. This culminated in an invited review in Reviews of Modern Physics, giving rise to other subsequent reviews over the years. In related work in 2014 together with [Beatriz](#), he showed how all *the low energy "miracles"*

*of Grand Unification could quite naturally emerge from an anthropic landscape of intersection brane models, without any GUT structure.*

Interestingly, in 2015 Bert and Beatriz worked with [Wim Ubachs](#) and [Edcel Salumbides](#) of the molecular physics group of the Vrije Universiteit on a paper on [constraints on extra dimensions from molecular spectroscopy](#). This was a very interesting and successful collaboration.

Also worth mentioning is that Bert has participated actively lecturing in more than a dozen Summer schools, and the like, and he has also been invited to give many colloquia, especially in European universities and research centers.

Outside Physics, Bert enjoys many activities, like cooking, skiing, taking photos and videos (making compositions with them), ... but *his passion, his second vocation after Physics is to compose, to create, music*. He started making music in 2006, using synthesizers and computer programs, and by now he has more than 200 compositions, between 3 and 6 minutes each, that amount to 17 hours (only during the COVID confinement he made about 30, filling four CDs).

Some other data of interest:

- About 136 works, including some 25 proceedings
- 5 reviews
- 28 publications as single author (excluding proceedings)
- More than 40 collaborators, Beatriz Gato-Rivera being the one with more papers together (14), followed by some others with 10.
- 17 articles with 100 or more citations (plus a few very close to 100), 4 with more than 200 citations, 2 more than 300 and 1 more than 500

Bert page in INSPIRE:

<https://inspirehep.net/literature?sort=mostrecent&size=25&page=6&q=find%20a%20Schellekens>