

Supersymmetry Theory Review

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Philosophy of the Supersymmetry Theory Review

- Provides motivation for supersymmetry (SUSY) searches
 - Theoretical arguments for TeV-scale supersymmetry (“naturalness”)
 - Acknowledges the tension between the motivation for new TeV-scale physics and the absence of SUSY signals at the LHC
- Establishes the theoretical framework for SUSY searches
 - Defines the parameters of the minimal supersymmetric model (MSSM)
 - Simplifying assumptions (CMSSM, GMSB, pMSSM, ...)
 - Brief mention of non-minimal extensions (NMSSM, RPV, ...)
- Provides the context for experimental SUSY searches
 - relevant for the SUSY Experimental review
 - relevant for the SUSY search listings of the PDG
- Provides an accessible theoretical review of supersymmetry and references for graduate students and researchers

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Main ingredients of the Supersymmetry Theory Review

- The supersymmetric parameters and particles of the MSSM
 - Superpartners: the targets of the SUSY searches
 - SUSY parameters: they determine the basic properties of the SUSY particles and their interactions
 - The (N)LSP and the relevance of missing energy
- Frameworks for the interpretation of supersymmetric phenomena
 - R-parity conservation vs. R-parity violation
 - Approaches to SUSY-breaking and their implications
 - Accommodating massive neutrinos
 - Beyond the minimal structures and assumptions
- Connections to the Higgs sector, flavor physics and dark matter
 - Implications of the observed Higgs boson ($m_H = 125$ GeV)
 - Constraints from the virtual exchange of SUSY particles
- Naturalness issues and the energy scale of SUSY breaking

What is omitted from the Supersymmetry Theory Review

- Comprehensive treatment of SUSY phenomenology and search techniques
- More details on dark matter and the Higgs sector in SUSY theories
 - Higgs and dark matter reviews provide places for these treatments
- A more comprehensive treatment of current constraints on SUSY models and parameters based on all available data (including SUSY searches and virtual SUSY effects)
- More on the implications of the negative results of SUSY searches
 - Expanding the discussion of the tension between naturalness and the absence (so far) of any observed SUSY signals
 - Theoretical approaches to addressing the little hierarchy problem
 - Possible holes in the standard SUSY searches
- Implications of SUSY for cosmology and the early universe

Major issues for the upcoming Supersymmetry Theory Review

- In the 2020 edition of the *Review of Particle Physics*, Ben Allanach will join me as a co-author for the next version of the Supersymmetry Theory review. He will subsequently take over as the sole author for the 2022 edition.
- Does the current SUSY Experimental review require modification of the SUSY Theory review (e.g. additional theoretical topics not presently covered or an enhancement of topics currently treated)?
- Do the SUSY Search Listings include searches that require further introductory material not currently present in the SUSY Theory review?
- Is there too much information in the SUSY Theory review?
 - Can the SUSY Theory review be (significantly) shortened?

Should the SUSY Theory and Experimental reviews be combined ?

- The possibility of combining the SUSY Theory and Experimental reviews into a single review has been considered in the past and may be re-evaluated in the future.
- One reason for rejecting this approach is that the time required to produce a unified review may be significantly larger than the total time to produce two separate reviews.
- Separated reviews produce cleaner results. Each review has its own constituency.
- With a new author of the SUSY Theory review about to come on board, now may be the time to reconsider this question.

You may be alone now,
but there *is* hope.



There is a theory that says
that, for each one of you,
there is a partner for you
somewhere out there.



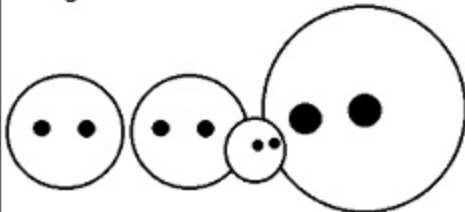
Your partner simply
hasn't been found yet.



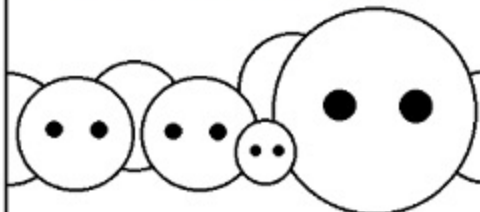
It doesn't matter what you look
like; it doesn't matter whether
you're attractive or not.



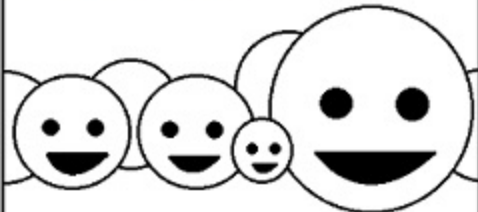
It doesn't matter how much
you weigh; whether you're
big or small.



It doesn't matter what your
personality is like; whether
you're charming or strange.



According to this theory, there is
a partner out there for each and
every one of you.



Unfortunately, there is no
compelling evidence to
support this theory yet.



So SUSY is probably wrong and
you're all SOL.

