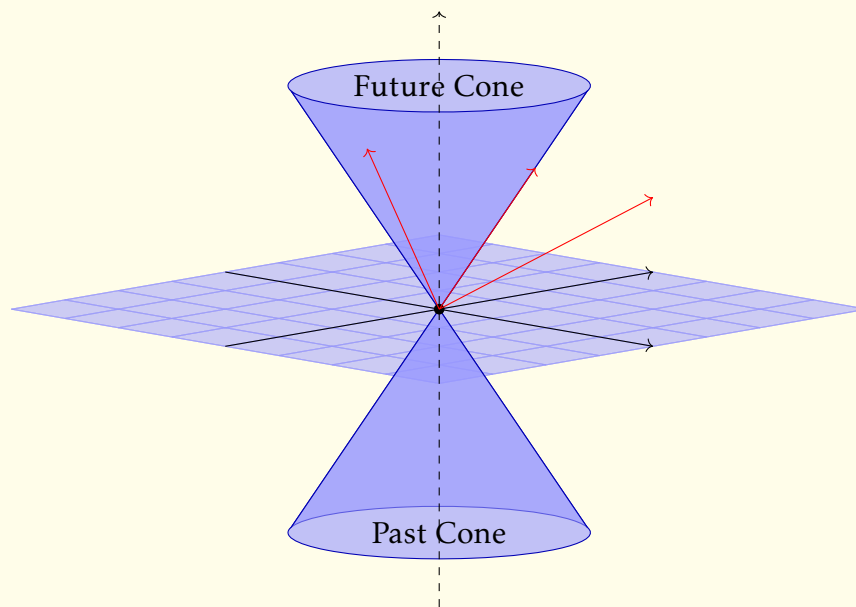


## Lorentzian and Semi-Riemannian Geometry



**Sachchidanand Prasad**  
Georg-August-Universität Göttingen  
Summer Semester 2025

## Course information

- **Course name** : Lorentzian and semi-Riemannian Geometry
- **Instructor** : Sachchidanand Prasad
- **Contact** : [sachchidanand.prasad@mathematik.uni-goettingen.de](mailto:sachchidanand.prasad@mathematik.uni-goettingen.de)
- **Office** - 2.110 (Institute for Numerical and Applied Mathematics, Lotzestraße, 37073 Göttingen)
- **Classroom** : SZ (Mathematisches Institut)
- **Time** : Friday 12:15 - 13:45
- **Course webpage** : [Link to the course website](#)
- **References** :

- [1] *Global Lorentzian Geometry*, by John K. Beem and Paul E. Ehrlich.
- [2] *Semi-Riemannian Geometry with Applications to Relativity*, by Barrett O'Neill.
- [3] *Techniques of Differential Topology in Relativity*, by Roger Penrose.

- **Evaluation** : The evaluation will be done by presentation of a project. A paper will be assigned to a group of students and they will present it in the class. The project will be evaluated based on the presentation and the report (a detailed writeup of the project) submitted.
- **Papers** : The following papers/projects will be assigned to the students for presentation:
  - ▷ **Existence of Lorentzian Metric on a Smooth Manifold** [O'N83]
  - ▷ **Wrapped products** [O'N83]  
*Study of the wrapped product of Lorentzian manifolds.*
  - ▷ **Paracompactness of Lorentzian Manifolds**  
*A smooth Hausdorff manifold admitting a Lorentzian metric is paracompact.*  
[A Condition for Paracompactness of a Manifold](#)[Mar73]  
 K. B. Marathe

- **Timelike Cut Locus**  
*Study of the timelike cut locus in space-time geometry.*  
[The Space-Time Cut Locus \[BE79\]](#)  
 J. K. Beem and P. E. Ehrlich
- **Null Cut Locus**  
*Exploration of the null cut locus in Lorentzian geometry.*  
[The Space-Time Cut Locus \[BE79\]](#)  
 J. K. Beem and P. E. Ehrlich
- **Morse-Index Theorem for Null Geodesics**  
*A theorem relating the Morse index to null geodesics in space-time.*  
[A Morse Index Theorem for Null Geodesics \[Bee75\]](#)  
 J. K. Beem
- **Comparison Theorems in Lorentzian Geometry**  
*Cut points, conjugate points, and their role in comparison theorems.*  
[Cut Points, Conjugate Points, and Lorentzian Comparison Theorems \[BE76\]](#)  
 J. K. Beem and P. E. Ehrlich
- **Geodesic completeness**  
*Geodesic completeness in submanifolds of Minkowski space.*  
[Geodesic Completeness of Submanifolds in Minkowski Space \[BE80\]](#)  
 J. K. Beem and P. E. Ehrlich

## References

- [BE76] John K. Beem and Paul E. Ehrlich. Cut Points, Conjugate Points, and Lorentzian Comparison Theorems. *Mathematical Proceedings of the Cambridge Philosophical Society*, 79(1):73–83, 1976.
- [BE79] John K. Beem and Paul E. Ehrlich. The Space-Time Cut Locus. *General Relativity and Gravitation*, 11(2):89–103, 1979.
- [BE80] John K. Beem and Paul E. Ehrlich. Geodesic Completeness of Submanifolds in Minkowski Space. *General Relativity and Gravitation*, 12(10):897–908, 1980.
- [Bee75] John K. Beem. A Morse Index Theorem for Null Geodesics. *Duke Mathematical Journal*, 42(4):707–714, 1975.
- [Mar73] K. B. Marathe. A Condition for Paracompactness of a Manifold. *Journal of Differential Geometry*, 7(3-4):571–573, 1973.
- [O’N83] Barrett O’Neill. *Semi-Riemannian Geometry with Applications to Relativity*, volume 103 of *Pure and Applied Mathematics*. Academic Press, San Diego, 1983.