

Research Results --- Yasuo Matsushita
For 2021 Academic Year
January 7, 2021

One of the major subjects of Professor Matsushita is the differential geometry and topology of indefinite metric spaces.

The Latest Results:

As a joint work with Peter R. Law, we established the following results:

If a Walker manifold of even dimension admits a parallel field of totally null 2-planes, then the three metric components can be constructed from a harmonic function of two variables, chosen arbitrary. (Submitted)

The main results are as follows:

1. The existence condition for a compact oriented 4-manifold to admit a neutral metric of signature $(++--)$ are settled. In relativity theory the existence condition of a Lorentz metric on a manifold is well-known. Therefore, the problem of the existence condition for the indefinite metric of neutral signature on 4-manifolds is interesting because such a metric is the lowest dimensional example of indefinite metrics not of Lorentz type. Its existence condition is known as same as the existence of a field of 2-planes. Applying Theorem of Hirzebruch and Hopf (1951) and Donaldson's works, celebrated as the Fields Prize in 1986, the existence condition of a neutral metric on a 4-manifold is expressed in terms of the Euler characteristic and the Hirzebruch index of the manifold, which are both topological invariants. These results are cited in Donaldson's Book "The Geometry of Four-Manifolds," published by Oxford University Press, in 1990.
2. One of the other significant results is to show a counter example constructed on a Walker 8-manifold to the Goldberg conjecture, posed in 1969, which states that an almost complex structure of a compact Einstein almost Kaehler manifold must be integrable, in other words, a compact Einstein almost Kaehler manifold must be Kaehler.
3. It is shown that the Euler characteristic and the Hirzebruch index must of a compact neutral Einstein 4-manifold must obey an inequality, which is similar to the Hitchin-Thorpe inequality for Riemannian-Einstein 4-manifolds, only except the sign.
4. Moreover, it is proved that such an existence condition of a neutral metric on a 4-manifold is equivalent to the existence condition of a pair of an almost complex structure and an opposite almost complex structure on the 4-manifold.
5. On the basis of the Enriques-Kodaira classification of compact 2-dimensional manifolds, usually called *surfaces*, it is shown that a surface admits an opposite almost complex structure if and only if the second Chern class of the surface is even.
6. Petean reported a new example of a neutral Einstein Kaehler 4-manifold. A general method of constructing new such examples of neutral Einstein Kaehler 4-manifolds are proposed in terms of arbitrary 2-dimensional harmonic functions.
7. Generalizing the notion of null vectors, we proposed isotropic tensors, with property of the zero squared norm of tensors. As one of the significant examples, a new

example of isotropic Kaehler structure is constructed on an Enle 4-manifold.

8. Recently, some substantial results are obtained on the spinor approach to neutral geometry of 4-manifolds.

The other activities: Mathematical Reviews Reviewer (from 1981). The Editor-in-Chief of JP Journal of Geometry and Topology. An Interview, with a photo, by Institute Of Physics of Great Britain was opened during several years in the IOP Home Page. A Chairperson of International Meeting in India. A Keynote Speaker in Symposium in Turkey. An External Examiner for PhD evaluation in King Saud University in Saudi Arabia. And may other such activities.