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Gravitomagnetic resonance and gravitational waves

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Gravitational waves are usually described in terms of a transverse and traceless (TT) tensor, which allows to introduce the so-called TT coordinates. However, another possible approach is based on the use of a Fermi coordinates system, defined in the vicinity of the world-line of an observer arbitrarily moving in spacetime. In particular, Fermi coordinates have a direct operational meaning, since they are the coordinates an observer would use to perform space and time measurements; indeed, using these coordinates the metric tensor contains (up to the required approximation level) only quantities that are invariant under coordinate transformations internal to the reference frame. Using this approach it is simple to emphasise that what an observer measures depends both on the background field where he is moving and, also, on his kind of motion. This is quite similar to what happens when we study classical mechanics in non inertial frames: inertial forces appear, depending on the peculiar motion of the frame with respect to an inertial one. We show that using Fermi coordinates the effects of a plane gravitational wave can be described by gravitoelectromagnetic fields: in other words, the wave field is equivalent to the action of a gravitoelectric and a gravitomagnetic field, that are transverse to the propagation direction and orthogonal to each other. In particular, the gravito-magnetic field acts on spinning particles and we show that, due to the action of the gravitational wave field a gravitomagnetic resonance may appear. We give both a classical and a quantum description of this phenomenon and suggest that it can be used as the basis for a new type of gravitational wave detectors.

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