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The space-wise approach for cold-atom interferometry geodetic data analysis: the MOCASS study

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In recent years, an innovative mission concept has been proposed for gravity measurements with the aim of continuously monitoring the Earth gravity and its changes. The concept is based on a satellite-borne interferometer exploiting ultra-cold atom technology. Among other studies, a team of researchers from Italian universities and research institutions proposed and carried out the MOCASS project, to investigate the performance of a cold atom interferometer flying on a low Earth orbiter and its impact on the modeling of different geophysical phenomena.

In this study, the basic idea was that of a GOCE follow-on mission, with a unique spacecraft carrying an instrument capable of measuring functionals of the Earth gravitational potential. The geodetic data analysis of the gravity gradient data attainable by such a mission was carried out following the space-wise approach developed at Politecnico di Milano. The mathematical model for the processing of the MOCASS data was formulated, including the filtering strategy applied to take into account the cold atom interferometer transfer function. Numerical simulations were performed, with different configurations of the satellite orbit and pointing mode of the interferometer; data were simulated for two cases: (i) a single-arm gradiometer observing T_{xx} or T_{yy} or T_{zz} gradients; (ii) a double-arm gradiometer observing T_{xx} and T_{zz} gradients or T_{yy} and T_{zz} gradients. The results of the simulations will be illustrated, showing the applicability of the proposed concept and the neat improvement in modeling the static gravity field with respect to GOCE.

Moreover, a new study called MOCAST+ has been lately started proposing an enhanced cold atom interferometer which can deliver not only gravity gradients but also time measurements. The study will investigate whether this could give the possibility of improving the estimation of gravity models even at low harmonic degrees, with inherent advantages in the modeling of mass transport and its global variations: this will represent fundamental information, e.g. in the study of variations in the hydrological cycle and relative mass exchange between atmosphere, oceans, cryosphere and solid Earth.