

## THE POSITIVE ENERGY THEOREM AND ITS EXTENSIONS

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### I. Introduction

Over the past few years there has been a dramatic increase in our understanding of **gravitational energy**. This has resulted mainly from the proofs of several long-standing conjectures in general relativity. Roughly speaking, these results state that one cannot construct an object out of ordinary matter, i.e., matter with **positive local energy density**, whose **total energy** including gravitational contributions is **negative**. Recall that in Newtonian gravity it is easy to construct objects of this type: Any bound system has negative total energy. In fact, since the Newtonian gravitational potential is unbounded from below, even if one includes the rest mass energy of the matter, one can still construct systems with negative total energy.

If similar objects existed in general relativity then they would have surprising properties. For example, since mass is equivalent to energy, such an object would have negative gravitational mass and **repel** rather than attract nearby objects. More importantly, one could presumably extract an unlimited amount of energy from such a system. This is because radiation will carry away positive energy, causing the energy remaining in the system to decrease. But since the total energy is negative initially, it appears to have **no lower bound**. It could thus continue to decrease **indefinitely**.

The results which have recently been established ensure that these bizarre situations cannot occur in the context of general relativity.