Photons and gravity

We distinguish photons from radio waves by the geometry of their electric and magnetic fields. Photons have localised fields and since an elementary charged particle consists of nothing but electric and magnetic fields, photons and particles are quite similar. They differ in the geometry of their electric fields with the consequence that the magnetic fields generated by their motion have different effects. For a particle, the effect causes a Lorentz contraction of the fields and leaves the energy content of the electric field unaltered. The kinetic energy is carried in the magnetic field generated by its motion. In a photon, the electric and magnetic fields are perpendicular and have equal effects on each other, so the distinction between kinetic energy and self energy disappears. A photon is all kinetic energy and instead of it being $\frac{1}{2} m v^2$ as in a particle, it is $m c^2$ counting the $\frac{1}{2} m c^2$ in the electric fields and the $\frac{1}{2} m c^2$ in the magnetic fields. (plural because it has several phases each with its own fields).

When a particle is in free fall, it gains kinetic energy and looses an equal amount of (electric) self energy. When it hits the ground, the kinetic energy is released while the particle with its self energy remains. When a photon is in free fall, there is no distinction between self energy and kinetic energy. It is in this sense quite unaffected by gravity. The only effect is that of gravitational potential on the permittivity and permeability of its fields increasing their ability to store energy with the result that they can travel at a slower speed while still generating the necessary feedback effects between electric and magnetic fields.

The energy content of photons is unaffected by gravity. A photon emitted from the sun appears red shifted because it had less energy when it was emitted than it would have had if the atom which emitted it was on earth. Gravitational red shift is therefore a window into the effect of gravitational potential on energy.

When a photon has a horizontal component to its velocity, the side nearest to the source of gravity will be travelling more slowly than the side further away. This will cause the photon's direction to alter in exactly the same way that light is affected when it passes through a medium which varies in refractive index.

The full mathematical analysis is given in the section Bending of Light.