Subject:
Physics text books for the upper secondary school introduce the concept of a photon: either as an energy portion that is exchanged in the process of absorption or emission of light, or as the constituent particles of light. Photons on the contrary are not mentioned in the majority of these books. This comes along with the fact that physics students at the university have a rather close idea of photons and a rather pale idea of phonons.

Deficiencies:
There is a far reaching analogy between photons and phonons. The classical theories of light and of sound have much in common, just as the corresponding quantum theories [1, 2]. The analogy manifests itself in various effects.

An example is heat transport with the one or the other particle. The carrier particles of a heat transport in a heat conductor of a material that is not an electric conductor are phonons. (In an electric conductor electrons dominate the process.) The process is diffusive, i.e. there is a continuous production and annihilation of phonons. Very similar is the heat transport within the sun from the reaction zone outwards. Here, the carrier particles are photons that are steadily emitted and absorbed.

The analogy also shows up in the temperature dependance of the energy of the phonon and the photon system in thermodynamical equilibrium. In both cases the energy varies as the forth power of the temperature (which in the case of photons is known as the Stefan-Boltzmann law). Thus both kinds of particles have much in common and do not merit to play such a different role in the teaching of physics.

Origin:
Phonons entered the physical scenery via the quantum-physical treatment of lattice vibrations. On the contrary, photons as the particles of light have a century-old tradition. In addition, single photons can easily be detected. Detectors for gamma and X ray photons exist since a long time, but today photons of visible light can also be detected with material that is not too expensive.

The fact that phonons are often called “quasi particles” may contribute to the belief that the phonon is a more abstract concept than the photon. Quasi particles are particles which owe their existence and their properties to their local environment. Actually it looks as if the distinction between quasi particles and the so-called normal particles is becoming obsolete, since we just learn that the normal particles owe their properties to the Higgs field.
Disposal:

1. Less reticence to introduce phonons and to treat them as particles. They are no more difficult than photons. We have found text books for the school which introduce gluons. So why not phonons that are certainly nearer to everyday physical phenomena than gluons.

2. A little more prudence when introducing photons.

3. More reticence in using designations like “quasi” or “virtual”. Such terms create uneasiness in the students’ minds about a concept and hardly explain anything.

[1] Ashcroft, N. W., Mermin, N. D.: Solid State Physics, Holt, Rinehart and Winston, Inc., Orlando (1976), p. 453: “In that theory [quantum theory of the electromagnetic field] the allowed energies of a normal mode of the radiation field in a cavity are given by $(n + \frac{1}{2})\hbar \omega$, where $\omega$ is the angular frequency of the mode. It is universal practice, however, to speak not of the quantum number of excitation of the mode, $n$, but of the number, $n$, of photons of that type that are present. In precisely the same way, instead of saying that the normal mode [in a crystal] of branch $s$ with the wave vector $k$ is in its $n_k s$ excited state, one says that there are $n_k s$ phonons of types with wave vector $k$ present in the crystal.”

[2] Vogel, H.: Gerthsen-Kneser-Vogel, Physik, Springer-Verlag Berlin (1977), p. 598: “A lattice vibration with the angular frequency $\omega$ can, just as the oscillation of a single particle, only have energy values whose differences are entire multiples of $\hbar \omega$. For this reason a light wave for instance can exchange only an entire multiple of this value with the crystal lattice. With the same justification as in the case of the electromagnetic wave field this is interpreted as the existence of acoustic quanta or phonons of energy $\hbar \omega$.”

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