Correction to "Bandwidth and Threshold Calculations for Angle-Tuned Parametric Oscillators"

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In the above paper[1], Basu and Steier have derived an expression [equation (18)] for the threshold of a single resonant optical parametric oscillator in which they take account of the effects of noncolinearity and walk-off of the interacting beams. In deriving (18), an erroneous assumption has been made, viz., that under low gain condition all three waves—pump, signal, and idler—may be taken to be constant over the length of the crystal. While this is a good approximation for the pump wave and the resonated wave (idler in their notation), it is not so for the nonresonant wave since this has zero amplitude at the entrance face to the nonlinear medium and grows to a level comparable to the idler amplitude by the time it reaches the exit face.

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[1] R. Basu and W. H. Steier, *IEEE J. Quantum Electron.*, vol. QE-8, pp. 693–699, Aug. 1972.

The effect of this error has been to make the predicted threshold pump power four times smaller than the correct value. To see this, one notes that for plane waves and for low gain the nonresonant signal field E_s grows linearly with distance propagated through the nonlinear medium (see, e.g., Harris[2]). Within the approximations made by Basu and Steier, it is therefore appropriate to take a signal field having a z dependence of the form $E_s(z) = E_s(\frac{1}{2} + z/l)$. At the entrance face to the nonlinear medium, $(z = -l/2)$, the signal field is then zero and at the exit face $(z = +l/2)$ the field reaches the value E_s.

Substitution of the above expression for $E_s(z)$ into Basu and Steier's analysis leads to values for idler and signal power gain ΔP_i and ΔP_s [equations (14) and (15), respectively in Basu and Steier], which are exactly half the values calculated in there. Equation (17) remains valid provided the one-way signal power P_s now refers to the power leaving the exit face of the nonlinear medium. It follows then that since the threshold power is proportional to $\Delta P_i \Delta P_s$, the predicted threshold power of Basu and Steier in (18) and in subsequent numerical examples is four times lower than the correct value.

[2] S. E. Harris, "Tunable optical parametric oscillators," *Proc. IEEE*, vol. 57, pp. 2096–2113, Dec. 1969.