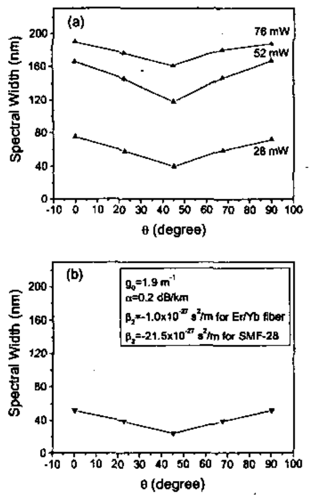

QThE5 Fig. 3. The polarization angle dependent spectral width of the CRSSS is shown for the results of (a) three different optical pump powers and (b) the simulation results for 17 mW. The inset is the parameters used for the simulation.

slow and fast axes are one. However, as the polarization angle approached both zero and 90 degrees, the nonlinear effect increasingly became larger.

This, we believe, is because the ratio of cross-phase modulation to the self-phase modulation in an isotropic medium such as silica fiber is 2/3. This is consistent with our experimental results and also is verified with our theoretical simulation results.

4. Conclusion

We have experimentally demonstrated and theoretically investigated the generation of cascaded Raman self-frequency shifted soliton in Er/Yb-doped fiber amplifier and its dependence on input polarization. The number of cascaded Raman solitons generated increases as a function of optical pump power of the fiber amplifier, while different input polarization condition results in different amount of soliton frequency shift.

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QThE6 11:45 am

New Analytical Solution and Cavity Effects in Multi-frequency Raman Generation

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Symmetric and resonant two-colour pumping of Raman media maximise the parametric gain, $\int_0^Z \mathrm{Re}[P(Z')]dZ'$, and hence lead to the maximum number of higher order lines generated.[1,2] Investigations have accounted for transient and transverse effects, along with nonlinear competing effects and the use of both H_2 and air as Raman media. More recently, model equations have been re-derived and expressed in terms of the molecular coherence ρ_{ab} (proportional to medium polarisation P) and phased and anti-phased states.[3] Adopting the notation of this latter approach, one concludes that maximum coherence requires maximum $|B|/[\Delta\omega - 1/2(D - A)]$; symmetric pumping is precisely the requirement to obtain the highest value of $|B|$, while resonant pumping is, by definition, minimising the denominator of this expression. It should be stressed that the authors of[2] also employed a Bessel function solution, from the classic work of Eimerl *et al*,[4] to construct sub-femtosecond pulses from the superposition of Raman lines.

In this presentation, we shall report two new contributions to this research field. Firstly, we have derived a new analytical solution that constitutes an explicit and lucid representation in terms of initial parameters and net detuning from resonance. Secondly, we shall present results from the first theoretical investigations of ultra-broadband Raman effects in cavities; dramatic modifications to the efficiency and character of the process are predicted.

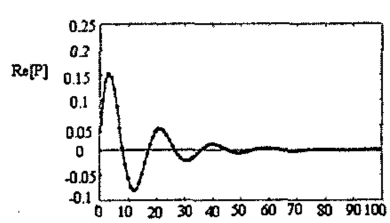
In systems with low normalised dispersion, we will show that the evolution of medium *P*, as a function of normalised propagation distance *u* (proportional to *Z*), is given by:

$$P(u) = \alpha\sqrt{1+\delta^2}\,\mathrm{cosech}(\alpha u + \beta)\,\exp i\varphi(u) \quad (1)$$

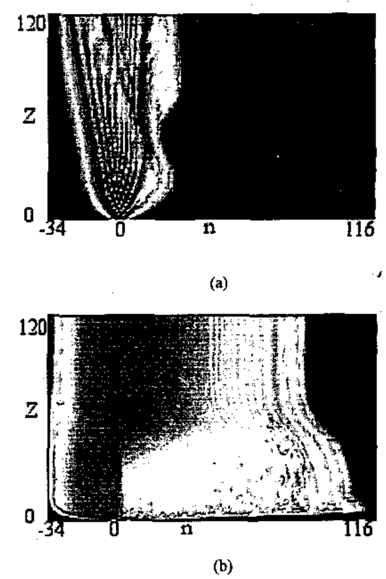
$$\varphi(u) = \delta \ln |\sinh(\alpha u + \beta)/\sinh(\beta)| + \varphi_0 \quad (2)$$

where α and β are constants and δ is the net detuning from resonance (see Fig. 1).

Recent improvements in fabrication techniques have led to the development of very low loss mirrors[5] and the subsequent design of CW



QThE6 Fig. 1. Real part of the polarisation wave as a function of normalised distance.



QThE6 Fig. 2. Spectral intensity evolution with propagation distance: (a) a traditional Raman cell of length of Z = 120, (b) the equivalent propagation distance within a pumped cavity.

Raman lasers. Motivated by the possibility of multi-frequency CW Raman lasers, and thus massively reduced pump requirements for the generation of ultra-broadband spectra, we have undertaken a systematic exploration of the role of cavity effects. Initial work has focussed on the consequences of periodic loss and pumping, whereby normalised cavity length Z_c and the level of lumped linear loss R are key parameters. In the absence of cavity effects, rotational Raman generation in 1 atm H_2 can lead to around 40 to 50 Raman lines of comparable energy under optimal conditions (Fig. 2(a)).

We predict that cavity effects lead to profoundly different results; output bandwidths can increase by well over 100% and self-organisation across the spectrum is possible. Part (b) of Fig. 2 shows the (stable) output from a Raman cavity that has a length of Zc = 0.2 and a combined reflectivity of R = 0.9425.

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