Raman phase conjugator

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We have developed a multipurpose high pressure gas cell which can be used to generate phase conjugate beams using various stimulated scattering processes. This high pressure cell can also be used as a tunable laser source using the process of stimulated Raman scattering. The phase conjugate nature of backward scattered Raman signals was investigated through distortion correction studies.

STIMULATED Raman scattering (SRS) has been used for many years to tune the frequency of a laser by an amount equal to the Raman mode of a molecule. SRS stems from basic spontaneous Raman scattering process in a medium. In spontaneous Raman scattering, the virtual transition from the initial state *a* of a system to a state *b* with higher energy takes place with an absorption of photon from an external electromagnetic wave of frequency ω_l. The relaxation of this excited state *b* to a state *c* is accompanied by a spontaneous emission of a photon with the Raman frequency ω_s which is called the Stokes wave since $\omega_s < \omega_l$. If the system is already in an excited state to begin with, it may take a transition downward when the light is scattered. In that case the scattered light contains anti-Stokes frequencies ω_{as} which are larger than the incident frequencies.

When the intensity of the incident photons at frequency ω_l is high, the intensity of the scattered photons at ω_s will also be high. This increase in intensity at ω_s leads to an induced transition from state *b* to state *c* due to the rescattering of these photons. These induced transitions are also known as stimulated transitions. These stimulated transitions are the reason for the nonlinearity of SRS, since their probabilities depend on the intensity of incident photons, in contrast to the probabilities of spontaneous transitions. These induced transitions with a frequency ω_s contribute the fundamental component of SRS. Thus in SRS the incident wave of frequency ω_l induces a polarization wave at frequency ω_s in the medium. This emergence of fundamental component has no bearing on the need to satisfy the phase matching condition. At sufficiently high intensities this generated Stokes signal can act as a powerful pump beam and can get scattered further by interacting with the original pump beam. These are four-wave mixing interactions such as coherent (anti-)Stokes Raman scattering. These generated new waves are at frequencies $\omega_l \pm n(\omega_l - \omega_s)$, where $n = 1, 2, 3, \ldots$. These are the well-known higher-order Stokes and anti-Stokes components in SRS[1].

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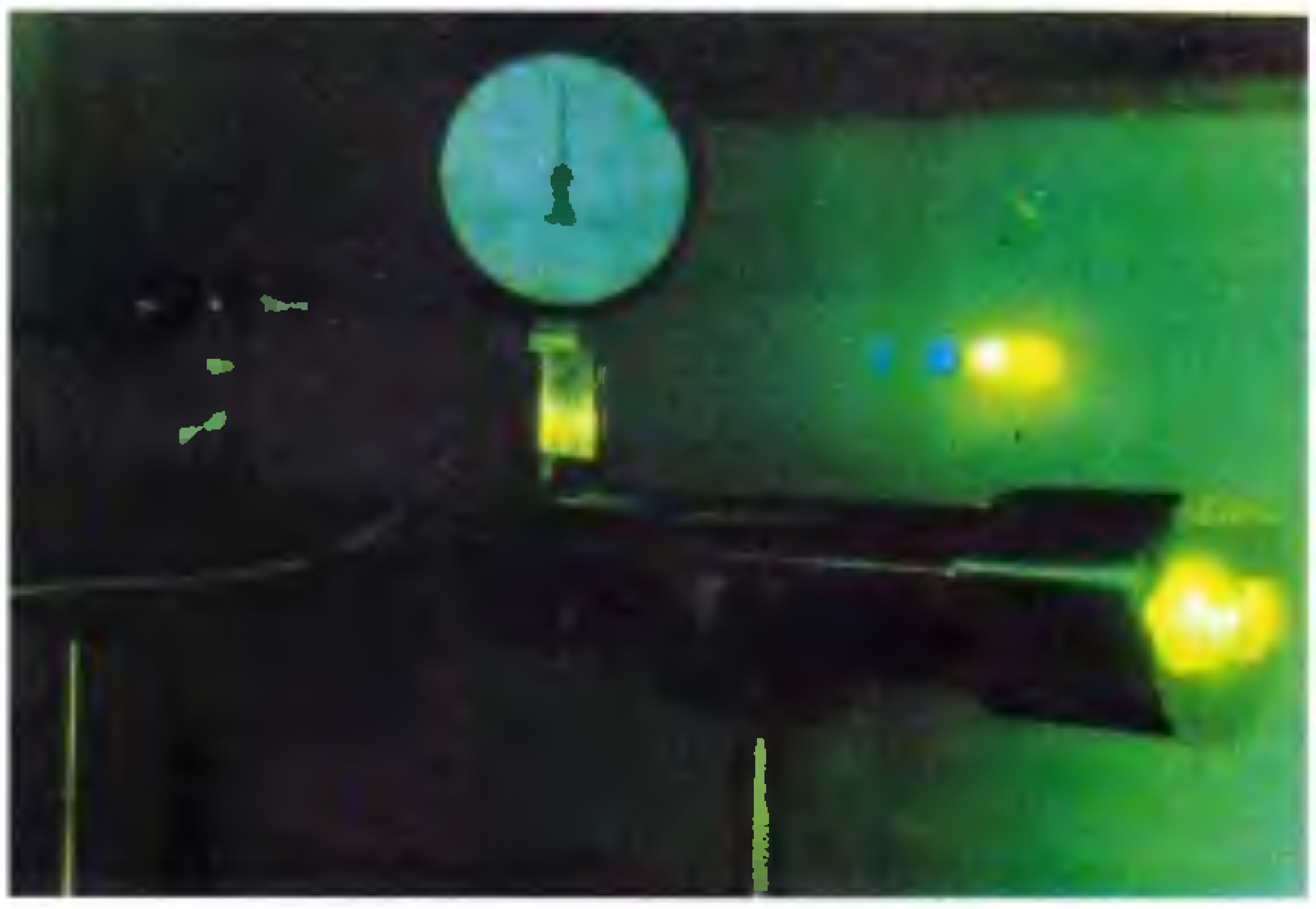

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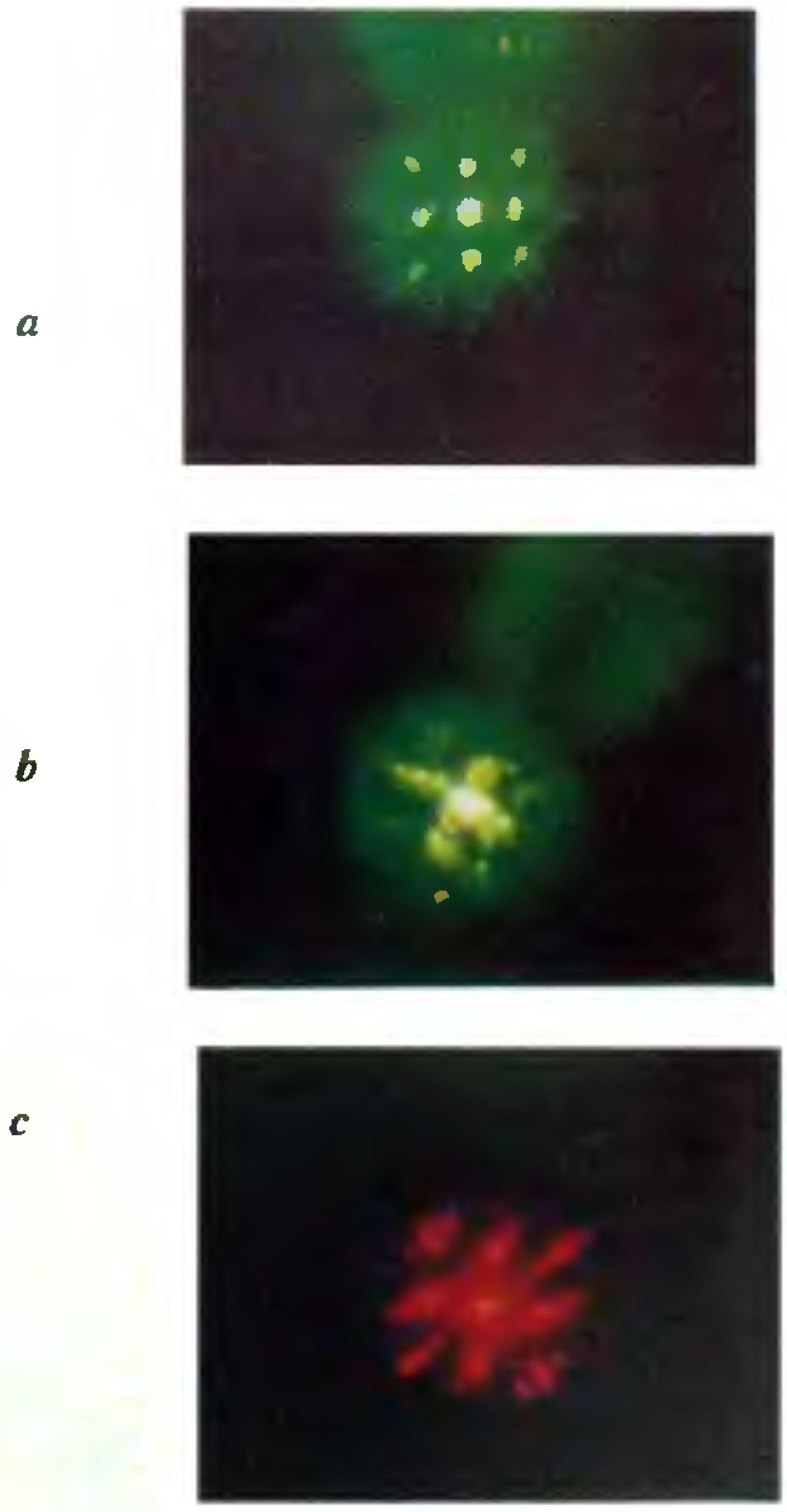

Figure 1. Distortion correction property of backward scattered SRS signal *a*, original signal, *b*, distorted original signal on passing through the phase distorter, *c*, phase conjugated first Stokes signal on reverse passage through the phase distorter

source using the process of SRS. The cell is made of stainless steel and can be used up to pressure as high as 400 kg cm^{-2}. The general idea is to study the role of various physical parameters of the nonlinear media and the laser parameters in these scattering processes. A frequency doubled Nd : YAG laser has been used as the pump source and SRS studies have been carried out in gaseous nitrogen. The Stokes and anti-Stokes signals including the higher orders were separated using a three-prism spectrograph. Measurements were made both on the forward and backward scattered Raman signals. Detailed investigations were carried out to study the role of various physical and laser parameters on SRS gains and the results have been the subject of several publications. Finally the phase conjugate nature of SRS signals was studied in detail by doing distortion correction experiments[2]. The distortion correction property of the first Stokes beam is shown in Figure 1. It can be seen that the correction ability of these backward scattered signals is good despite a large frequency shift, thus confirming their phase conjugate nature.

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Chemical analysis and ^{14}C dating of a sediment core from Tsokar lake, Ladakh and its implications on climatic changes

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The climatic changes around Tsokar lake, Ladakh have been inferred on the basis of analysis of elemental, organic and mineral content variations in 23-m-long sediment core covering a time span of 32 ky in the past to the beginning of Holocene. Nine zones have been identified for the interpretation of the chemical data in terms of climatic change. The results show that climate was generally dry arid prior to 30.4 ky BP and during the intervals of 28.5 to 18.9 ky BP, 16.4 to 15.9 ky BP, 14.9 to 12.6 ky BP and 11.6 to 10.7 ky BP followed by brief ameliorations of wet-humid phase during intervening periods.

CHEMICAL analysis of lacustrine sediments was found to be a potential tool to reconstruct the climate and to decipher the development of former ecosystems[1–4]. In fact it has been shown that the conclusions derived from chemical analysis are in close agreement with those derived from such other proxy data based on pollen, diatoms, microfossils, etc. The basis for this study lies in the fact that the concentration and nature of chemical constituents in the sediments are the cumulative effect of both biotic and climatic changes. Any variations in chemical constituents of sediments both in quantity and type reflect changes not only in aquatic environment but also in the surrounding terrestrial environment.

So far in India not much work has been carried out on the chemical analysis of lacustrine sediments. Only one report was published on the past climatic and environmental changes during the last 500 y from Paradip Island, Orissa[5]. In this paper an attempt has been made to reconstruct climatic as well as environmental conditions in the trans-Himalayan region during late Pleistocene using chemical analysis data supplemented with ^{14}C dates on a 23-m-long bore core (TP 6) collected from Tsokar lake, Ladakh.

The sediment core was collected by the Geological Survey of India (GSI) from Tsokar lake situated at an altitude 4572 m above mean sea level (MSL) in Ladakh, J & K State (32° 15′ to 36° N and 75° 15′ to 80° 15′ E). The Tsokar lake occupies an area of 250 km^2 in Chang Thang Rupsu region about 125 km SE of Leh and is surrounded by hills of Zanskar range (altitude 6000 m MSL) in trans-Himalayan region. The water is brackish as a result of continuous evaporation.

Sixteen samples at different intervals from the 23-m-long bore core, (TP 6) were analysed to understand the variations in chemical constituents as well as organic and mineral contents. The sediments mostly comprised of clay with horizons of sand, gravel, pebbles and thin layers rich in leaf fragments. For further details on the core and its lithology reference is made to Bhattacharyya[6].

As carbon contents were low, excepting for one sample with biogenic remains, ^{14}C age measurements could be carried out only on four samples in this profile using standard procedure[7].

From the plot of ^{14}C dates vs depth (Figure 1) it is seen that the best fit line (1st order regression) is very close to measured ages (within 1 σ errors). The rate of sedimentation can therefore be considered to be constant with a value of 9.5 cm/100 y. The best fit line gives an age of 9.7 ky for the surface deposit. Since the core was collected from the dry lake margin, we believe that the original surface was eroded away. This is also supported by the ^{14}C age of 7080 ± 130 y (BS-271) obtained for the surface sample elsewhere from dry lake bed in Tsokar.

For chemical analysis each sample was separated into