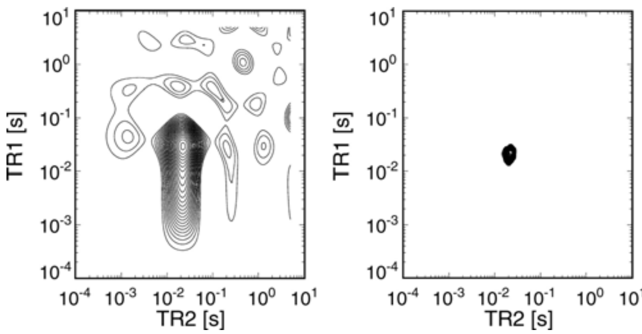

noise has been added. The included figure shows the recovery of an initial sharply peaked 2D Gaussian amplitude field by using the BRD algorithm for a peak-to-noise ratio of 2000. The solution applying positivity constraints (right) recovers the initial Gaussian peak almost perfectly, while the minimum norm solution matches the peak position, but is significantly less accurate. In particular, we address methods suitable for 3D and higher dimensions.

Finally, we present applications of the inversion procedure to real experimental 3D and 4D datasets and comment on signal-to-noise issues and performance of the inversion methods.

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Improved noble gas polarization production for porous and granular media studies using narrowed-line VBG laser sources

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Laser-polarized xenon NMR and MRI are powerful, noninvasive diagnostic tools. We have used them to study (i) porous media microstructure, determining long-length scale parameters [1]; (ii) gas-phase dynamics, measuring inter-phase exchange rates in granular systems including fluidized beds [2]; (iii) more general two-phase fluid dynamics studies such as laminar gas flow and convection in a gas/liquid system [3]; and (iv) xenon-soluble soft porous media, measuring the surface area of complex materials by monitoring the exchange of xenon from the gaseous to the dissolved phase [4]. Small, home-built noble-gas laser-polarization systems that generate limited amounts of laser-polarized ^{129}Xe have been used for studies like those above. However, practical problems encountered with the quality of laser hardware and the resultant attainable production rates of laser-polarized xenon have yielded results that are limiting or, in some cases, have restricted research applications completely.

For ^{129}Xe, a key technical problem related to the low levels of polarization often obtained is the amount of resonant laser light that is actually obtainable from the current generation of laser diode arrays (LDA). Although such lasers may be rated at 60 W or higher, their optical spectra are broad, with the desired wavelength of 795 nm generally appearing as a broad peak of ~3 nm width. As a result, relatively little of the rated laser power is actually resonant for the Rb transition in the spin exchange optical pumping process that drives the xenon polarization — as shown in Fig. 1. We have shown that achievable ^{129}Xe polarization can increase by a factor of 2 or more with a reduction in laser line-width of a factor of 5.

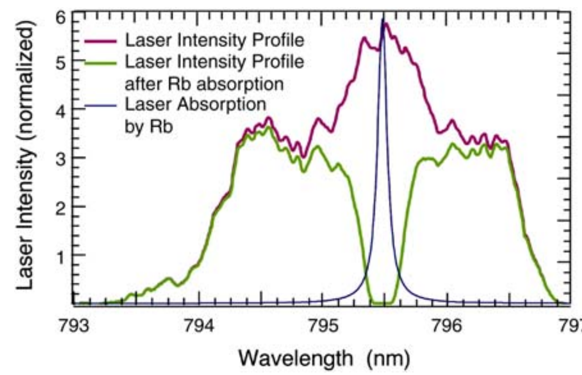

Fig. 1 Laser line-shape from a typical LDA commonly used for spin-exchange optical pumping. The pink line is the measured laser output, the green line is the laser spectrum after travelling through an optical pumping cell. The blue line is the calculated laser absorption by rubidium in the spin-exchange process, for common 129Xe operating parameters.

We have recently implemented a new laser diode bar incorporating a volume Bragg grating (VBG) [5]. Only currently under development by laser vendors, the VBG is in effect a frequency selective mirror used as an intra-cavity feedback device with the LDA, resulting in minimal laser power reduction while providing a narrow resonant line output of ~0.2 nm FWHM. Chirped VBG's can be "tuned" over a range of approximately ± 1 nm by precisely adjusting the positioning of the grating or as a function of VBG temperature by varying the laser power incident on the VBG. When optimized, the VBG-narrowed laser will provide a two- to fivefold polarization increase as well as improved production rate for direct incorporation into our granular media studies.

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Microscale flow analysis in trabecular vertebral bone

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Background and Objectives: This abstract reports on the analysis of fluid flow in structured porous media that is relevant to a biomedical application. This application is a minimally invasive procedure designed to treat vertebral compression fractures. These fractures constitute 45% of all osteoporosis-related fractures and, thus far, cannot be treated effectively. The new procedure consists of injecting a medical polymer, or cement, through a thin cannula into a vertebral body where the cement infiltrates the bone cavities. The cement once hardened in situ offers reinforcement to the bone weakened by osteoporosis. Although this procedure expanded rapidly, its use is currently limited because without clear guidelines its safety can be seriously compromised, mainly because of the lack of understanding and prediction of cement flow within the bone cavities and, consequently, cement filling. This computational paper takes a bottom-up modeling approach, in which individual bone cavities are discretized to subpore resolution and the fluid solid interaction is modeled at the pore scale.

Methodology: Two separate methods have been used. (1) Microscanning: It was applied to cylindrical cores excised from cadaveric vertebrae. The scanning resolution was 18.6 μm. (2) Microscale simulation: It was based