



Physical Sciences

Method for Accurately Calibrating a Spectrometer Using Broadband Light

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A novel method has been developed for performing very fine calibration of a spectrometer. This process is particularly useful for modern miniature charge-coupled device (CCD) spectrometers where a typical factory wavelength calibration has been performed and a finer, more accurate calibration is desired. Typically, the factory calibration is done with a spectral line source that generates light at known wavelengths, allowing specific pixels in the CCD array to be assigned wave-

length values. This method is good to about 1 nm across the spectrometer's wavelength range. This new method appears to be accurate to about 0.1 nm, a factor of ten improvement.

White light is passed through an unbalanced Michelson interferometer, producing an optical signal with significant spectral variation. A simple theory can be developed to describe this spectral pattern, so by comparing the actual spectrometer output against this predicted pattern, errors in the wavelength

assignment made by the spectrometer can be determined.

The primary unique feature of this innovation is its ability to calibrate every pixel across a given wavelength range as opposed to only calibrating a few pixels and interpolating the other values as is currently done.

This work was done by Stephen Simmons and Robert Youngquist of Kennedy Space Center. Further information is contained in a TSP (see page 1). KSC-13331

Catalytic Microtube Rocket Igniter

This device can also be used on commercial combustion devices such as furnaces, power generators, and gas-fueled cooking appliances like grills, ranges, and ovens.

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Devices that generate both high energy and high temperature are required to ignite reliably the propellant mixtures in combustion chambers like those present in rockets and other combustion systems. This catalytic microtube rocket igniter generates these conditions with a small, catalysis-based torch. While traditional spark plug systems can require anywhere from 50 W to multiple kW of power in different applications, this system has demonstrated ignition at less than 25 W. Reactants are fed to the igniter from the same tanks that feed the reactants to the rest of the rocket or combustion system. While this specific igniter was originally designed for liquid methane and liquid oxygen rockets, it can be easily operated with gaseous propellants or modified for hydrogen use in commercial combustion devices.

For the present cryogenic propellant rocket case, the main propellant tanks — liquid oxygen and liquid methane, respectively — are regulated and split into different systems for the individual stages of the rocket and igniter. As the catalyst requires a gas phase for reaction, either the stored boil-off of the tanks can be used directly or one stream each of

fuel and oxidizer can go through a heat exchanger/vaporizer that turns the liquid propellants into a gaseous form. For commercial applications, where the reactants are stored as gases, the system is simplified. The resulting gas-phase streams of fuel and oxidizer are then further divided for the individual components of the igniter.

One stream each of the fuel and oxidizer is introduced to a mixing bottle/apparatus where they are mixed to a fuel-rich composition with an O/F mass-based mixture ratio of under 1.0. This premixed flow then feeds into the catalytic microtube device. The total flow is on the order of 0.01 g/s. The microtube device is composed of a pair of sub-millimeter diameter platinum tubes connected only at the outlet so that the two outlet flows are parallel to each other. The tubes are each approximately 10 cm long and are heated via direct electric resistive heating. This heating brings the gasses to their minimum required ignition temperature, which is lower than the auto-thermal ignition temperature, and causes the onset of both surface and gas phase ignition producing hot temperatures and a highly

reacting flame.

The combustion products from the catalytic tubes, which are below the melting point of platinum, are injected into the center of another combustion stage, called the primary augments. The reactants for this combustion stage come from the same source but the flows of non-premixed methane and oxygen gas are split off to a secondary mixing apparatus and can be mixed in a near-stoichiometric to highly lean mixture ratio. The primary augments is a component that has channels venting this mixed gas to impinge on each other in the center of the augments, perpendicular to the flow from the catalyst. The total cross-sectional area of these channels is on a similar order as that of the catalyst. The augments has internal channels that act as a manifold to distribute equally the gas to the inward-venting channels. This stage creates a stable flame kernel as its flows, which are on the order of 0.01 g/s, are ignited by the combustion products of the catalyst. This stage is designed to produce combustion products in the flame kernel that exceed the auto-thermal ignition temperature of oxygen and methane.