To record the image of a sunset we point the camera toward the setting sun, and the rays diverging from the various elements of the scene fall on the lens and are focused, element by element, on the film. Some people undoubtedly conceive of a camera as a device that reaches out and captures the distant scene, and years ago it was vigorously contended that vision reached out from the eye much as a hand reaches out in a dark room to explore the surroundings. It is, of course, perfectly all right to describe photography as in the introductory sentence above, but with the caveat that the description involves information about certain entities (the source elements and the propagation medium) that are unascertainable by the camera alone. In many branches of science the output of the observing instruments is the only information—astronomy is one example, and seismic exploration of the earth’s interior is another. Both of these endeavors produce images of inaccessible regions of physical space, and they suggest another, more operational, way of describing image formation.

**IMAGE EXTRACTION FROM A FIELD**

The objective lens of a refracting telescope is immersed in an electromagnetic field of optical frequency that exists at the telescope. The telescope does not reach out into celestial space at all. On the contrary, the lens is in contact with a terrestrially situated field, and the image on the film is formed by electric fields produced at the film when the image-forming
instrument, in this case a telescope, operates on the field available to it at the big lens. The
same is true of a seismic geophone array, which, far from reaching into the interior of the
earth, is merely in contact with the quaking surface of the earth.

By discussing the entities that are available to an instrument to operate upon, rather
than emissive or scattering elements in inaccessible regions, we get a tighter, if less famil­
 iar, theory.

Now consider the following question. One can see that the sun is a bright circular
object half a degree in diameter. Therefore, at the surface of the lens of the eye, or on any
other surface on earth, such as the surface of paper exposed to sunlight, the optical electro­
magnetic field contains the information about the circular form and the diameter. Where in
the electromagnetic field on the intercepting surface does this information reside?

If you could record the electric field at a point in full and precise detail as a function
of time, you would know everything that could be known about the field at that point, and
you could ascertain the spectrum of sunlight and the solar constant, or how many kilowatts
fall on a square meter. But you could not deduce the shape of the sun. If you recorded
the field at any other point on earth, the recording would be different in detail, but the
intensity and the spectrum would be the same. So how does an instrument such as the eye
or a camera operate on such data to extract an image?

The answer is that the fields at adjacent points are different but not independent; the
way in which the dependence varies with the spacing of the points contains the information
about the image. To specify the image-forming characteristic of the field we must deal
in terms of coherence as a function of vector spacing on the intercepting surface. To
understand the coherence of the field is to lay the foundation for an appreciation of a broad
class of image-forming instruments.

**INCOHERENT RADIATION SOURCE**

We say that the field variations at two points in space are coherent if they possess such
phase relationships as to permit interference. Starting from this basis, we can expand the
concept of coherence. For example, a single waveform, such as the output from a signal
generator, or the carrier wave from a radio transmitter, or the waveform supplied by the
power distribution network, is sometimes said to be coherent. This statement can be given
meaning in terms of our point of departure if two waveforms, generated from the one
waveform by counting from two different instants of time, can interfere.

Of course, one sees immediately that the question whether or not a waveform is co­
herent cannot be answered without reference to the time interval between the two selected
instants, because it is quite conceivable that a waveform may be coherent over a short time
interval but not over a long one. This thought underlies the notion of coherence interval, a
time interval characterizing the fall-off in coherence as the time interval is increased. In the
case of a traveling wave the corresponding term coherence length may be applied. Thus, an
optical waveform might be split into two wavetrains by a transparent mirror and reunited
after one has traveled farther than the other, and it might be found that interference occurs,